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Journal

—OF THE—

American Ceramic Society

TOGETHER WITH

CERAMIC ABSTRACTS

A Monthly Journal devoted to the Arts and Sciences Related to the Silicate Industries

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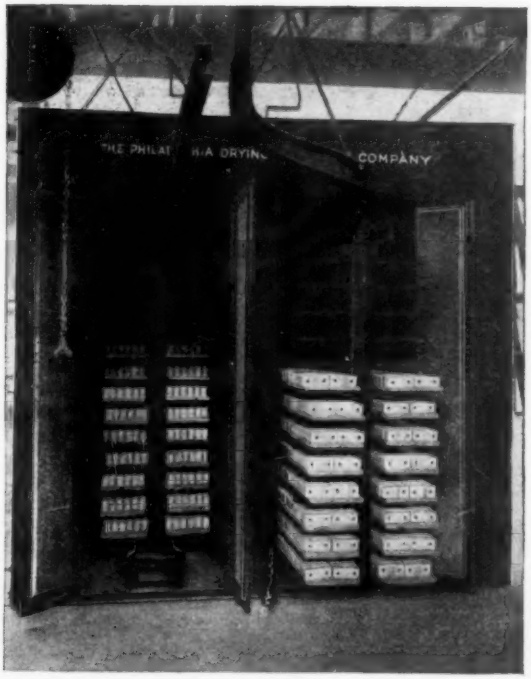

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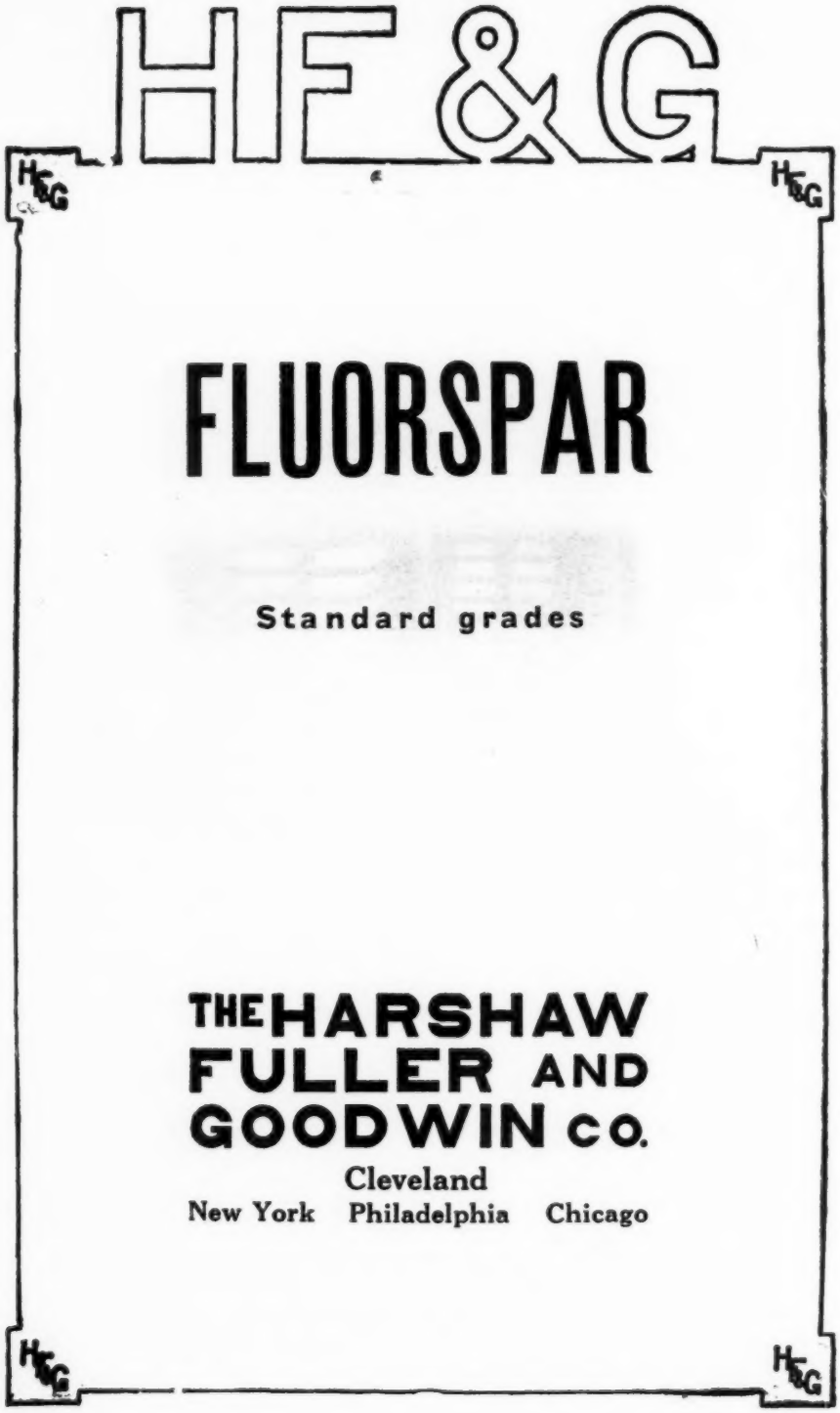

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JOURNAL

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A monthly Journal devoted to the arts and sciences related to the silicate industries.

Editor: E. W. WASHBURN; **Associate Editors:** L. E. BARRINGER, A. V. BLEININGER, R. L. CLARE, E. P. POSTE, H. RIES, F. H. RHEAD, R. B. SOSMAN, R. T. STULL, E. W. TILLOTSON

Vol. 5 **January, 1922** **No. 1**

EDITORIAL

THE SEASON'S GREETINGS

WHAT SHALL THEY BE?

Our Society was conceived out of the great need for coöperation of Ceramists in Research. Under the far-seeing and inspiring leadership of Professor Edward Orton, Jr., this idea of coöperation was crystallized into the American Ceramic Society. After twenty-three years of consistent promotion of the fundamental principles and benefits of coöperation in technical and scientific research, we have reasons for rejoicing over the fact that many of the Ceramic Trade Associations are financing researches and that the ceramic manufacturers are coöperating.

This is the season of Good Will and of Resolutions. These are the fundamentals of coöperation. May each member of the Society give thought to what he can do to perfect the "team work" by which and only by which our Society can continue to be the stimulating and activating influence in coöperative ceramic research. The holding of conventions and the publication of records of researches is not sufficient. If more than this is not done by the American Ceramic Society some other organization will of necessity be formed. There is need for promoting coöperation between the producer and the user of ceramic wares and between each of these and the federal, collegiate and semi-

public laboratories; and this promotion can best be secured by specialized groups, our Industrial Divisions, coördinated through the standing committees of the Society.

The American Ceramic Society is providing and must to a larger degree provide opportunity for the producer, the user and the laboratories to come together to report, discuss and record the results of the researches which each is supporting or conducting. This brings to the Industrial Divisions an opportunity. May each member of the Society, each Industrial Division, each Trade Association and each of the laboratories keep foremost the benefits of coöperation, coöperation between the producer, the user and the laboratories; and coöperation between the several Industrial Divisions within the Society. Coöperation is the carrying out of the principles of Good Will. Maximum coöperation requires a resolution on the part of each member of the Society to do team work with his fellow member on this Good Will program.

We must have the "best ever" convention in St. Louis, February 27th, and we must enlist a large number of ceramic workers and ceramic corporations in the support of this, the beginning and the end of organized coöperation, The American Ceramic Society. This convention and this membership campaign are occasions calling for the most perfect team work. The Program Committee and the Membership Committee need and ask for the assistance of every member of the Society. You will find inspiration for supporting the work of these two committees in "Good Will" coöperation in Research which the Society has developed and to which it must now give even more attention.

"Service" is the best of this Season's Greetings.

ROSS C. PURDY

ORIGINAL PAPERS AND DISCUSSIONS

THE MICROSCOPIC EXAMINATION OF THE MINERAL CONSTITUENTS OF SOME AMERICAN CLAYS[1]

By H. G. Schurecht

ABSTRACT

The difference in structure of the English and American clay grains and mineral constituents were examined under the microscope.

English kaolin consists chiefly of crystalline kaolin being similar to North Carolina kaolins in this respect. Georgia, South Carolina and some Pennsylvania clays consist largely of "colloidal" kaolin, which accounts for their difference in physical properties.

The objectionable abrasive features of the American clays causing excessive wear to machinery can be readily overcome by more "refined" refining methods but it is impossible by any present known methods or process to transform the colloidal kaolinite particles of our transported clays into the crystalline plate-like structure of the English china clay.

Our only hope therefore, of producing clays in this country which will be as satisfactory as those now imported, lies in the development of the crystalline kaolins. This is possible by better mining, blending and refining processes. However, the total tonnage of clay in our crystalline kaolin deposits is limited and if drawn upon intensively they would soon be exhausted.

Minerals found present in the clays are chiefly muscovite, quartz, tourmaline, biotite, zircon, alkali feldspar, plagioclase, rutile, hydrated silica and hematite.

Introduction

The average annual consumption of clays classed as kaolins and china clays in the United States, for the period of 1909–1918, amounted to 404,000 tons.[2] Of this sum 250,000 tons or 62 per

[1] Received March 10, 1921. Published by permission of the Director, U. S. Bureau of Mines.

[2] Average from statistical data "Clay Working Industries, Silica Brick and Building Operations in the Larger Cities in 1918," by Jefferson Middleton, U. S. Geological Survey.

cent were imported, most of it coming from England. These clays find uses principally as fillers for paper, oil cloth and paint and for ceramic purposes.

Manufacturers maintain that it is necessary to use imported china clays for the better grades of paper, oil cloth and pottery and that the substitution of the domestic clays has not been entirely satisfactory. It is therefore evident that these imported clays possess desirable physical properties which have not been matched by our domestic clays. That these differences have not been entirely revealed by the ordinary laboratory tests is a well known fact.

American clays have been found which approach the English china clays in fineness of grain, plasticity, shrinkage, dry strength and color, but still the two clays behave differently when applied to commercial practice.

A comparison of the behaviors of English china clay and Georgia kaolin is of interest. The former clay disintegrates in water more readily, produces a body which casts more satisfactorily, gives lower drying and bisque losses, is less abrasive to oil-cloth and paper-making machinery, requires less linseed oil to produce a spreading condition for oilcloth and produces a paper of better finish and more resistant to moisture.

In endeavoring to explain the causes of these differences and to determine wherein the clays differed in structure, the Bureau of Mines undertook a microscopic study of the different sized grains of a number of clays in order to determine qualitatively the mineral constitution and physical character of the grains.

Although the work is not completed, it has progressed far enough to indicate that many of these differences may be attributed to the physical differences in the grains themselves.

The English china clays consist mostly of distinct crystalline plates and platy aggregates of kaolinite, whereas Georgia and South Carolina clays are constituted largely of "colloidal" kaolin aggregates. Clays constituted of crystalline plate-like grains and aggregates as compared to those made up of "colloidal" aggregates show a much lower adsorption and will therefore, disintegrate more rapidly in the blunger, require less water to place them in a plastic condition for jiggering or fluid condition for casting, will

give up water more readily to the plaster mold and develop less drying strains. Due to lower adsorption, they also require appreciably less boiled linseed oil in order to place them in a fluid condition for spreading as oilcloth fillers, and as paper fillers they are less sensitive to a humid atmosphere.

The determination of the accessory minerals has also thrown considerable light on why some American clays are abrasive to oil-cloth and paper-making machinery. It has also thrown some light upon the possible origin of the clays.

A microscopic study of the clays fired to 1000°C frequently showed what minerals were responsible for the undesirable colors and served to indicate how such clays may be improved by better refining methods.

Experimental Methods

Each sample of clay was separated into nine different grain sizes by screening and elutriation[1] and each size examined separately under a petrographic microscope. The oil immersion method was used for determining the indices of refraction for identifying the minerals.[2]

The different grain size portions were then fired at 1000°C and their color noted by comparison with standard colors,[3] and the minerals causing the undesirable colors were examined under the microscope.

Results

English China Clays.—In Tables 1 and 2 are shown results of the microscopic examination of English china clays. Most of the kaolinite particles are present as platy crystals and aggregates of these plates, a feature which is characteristic of kaolins occurring near the mother rock. They can readily be identified by their indices of refraction, which lie between 1.56 and 1.57, and their low birefringence, 0.007. When examined on the flat side, some

[1] *This Jour.*, **3**, 355–78 (1920).

[2] For more complete details regarding the use of the petrographic microscope for ceramic materials see, "The Mineralogical Examination of Clays," W. J. McCaughey, *Trans. Amer. Ceram. Soc.*, **15**, 322–27(1913). "Examination of Commercial Spar.," *Ibid.*, **15**, 381–87(1913).

[3] Ridgway, Robt., "Color Standards and Color Nomenclature." U. S. National Museum, 1912. Washington, D. C.

of these plates appear to have dark centers, due to their concave shaped faces, whereby they can be distinguished from muscovite.

Muscovite and tourmaline are the most abundant accessory minerals. The muscovite is present largely as a fibrous mineral in which $\gamma = 1.583$ $\alpha = 1.560$. This mineral has properties nearer to sericite[1] than any other mineral and therefore was designated as sericitic muscovite.

Tourmaline can easily be identified by its strong pleochroism, negative elongation, parallel extinction and high index of refraction, γ being close to 1.64. Only a trace of alkali feldspar was found which was identified by its low index of refraction, which was less than 1.53. A trace of quartz was also found. This was identified chiefly by its index of refraction, 1.545, and + sign. When muscovite is calcined at 1000°C it appears very brilliant when examined in reflected light. Extremely small traces of muscovite may be detected in this manner.

Georgia White Clays.—In Tables 3, 4, 5, 6, 7 and 8 are shown the results of the microscopic examination of Georgia white clays. These clays contain a large proportion of extremely fine kaolinite differing from the English china clay which is composed of larger plates.

The fine kaolinite in Georgia clays is so fine that the particles can not be detected under the microscope even with a high power petrographic objective (Fig. 1). The index of refraction of this material is about the same as that for kaolinite, 1.563, and it was therefore called "colloidal" kaolinite to distinguish it from the coarser grained crystalline kaolinite, although no further tests were made to prove that this material was colloidal. Hydrated silica has an index of refraction of about 1.43 whereby it can be readily distinguished from "colloidal" kaolinite. Quartz and muscovite seem to be the most abundant accessory minerals. Small amounts of zircon and biotite are also present.

North Carolina Kaolins.—In Tables 9 and 10 are shown the results of the microscopic examination of North Carolina kaolins. These clays are similar to English china clay in that most of the kaolinite is present as platy crystals and aggregates of these

[1] "Elements of Optical Mineralogy," N. H. Winchell. D. Van Nostrand Co., 1909, 288.

(Fig. 2). These crystals are more distinct than those found in the English china clay. However, the North Carolina kaolins examined are coarser grained than the English and have a poorer color when fired at 1000°C. They also contain more quartz. By applying better refining methods to these clays, it may be possible to obtain a substitute for English china clays since these clays consist chiefly of crystalline kaolinite.

South Carolina White Clays.—In Tables 11 and 12 are shown the results obtained with South Carolina clays. These clays are similar to Georgia clays being composed largely of "colloidal" kaolinite which is characteristic of transported kaolins. They, however, contain less quartz and muscovite than the Georgia clays.

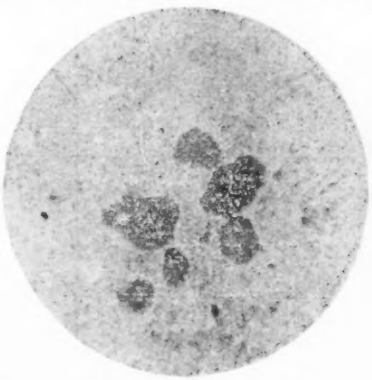

FIG. 1.—Georgia white clay. Magnified 40 diameters. Residue in can 1.

FIG. 2.—North Carolina kaolin. Magnified 250 diameters. Residue in can 1.

Pennsylvania White Clays.—In Tables 13 and 14 are shown the results of the microscopic examination of Pennsylvania clays. Sample 1.62 is similar to Georgia kaolin in that it contains mostly "colloidal" kaolinite, whereas sample 1.74 is similar to English china clay consisting chiefly of crystalline kaolinite.

The desirable properties of English china clays are evidently due to the fact that they are composed largely of crystalline plate-like kaolinite grains and are comparatively free from abrasive grains and objectionable coloring minerals when refined for market.

In conclusion the author wishes to acknowledge his indebtedness to Dr. W. J. McCaughey under whose direction this work was done.

TABLE I—1.01. ENGLISH CHINA CLAY. MOORE & MUNGER'S, M & M

Sample	RAW CLAY: Essential Minerals: Most abundant	RAW CLAY: Essential Minerals: Considerable	RAW CLAY: Accessory Minerals: Small amounts	RAW CLAY: Accessory Minerals: Trace	CLAY FIRED AT 1000°C: Color	CLAY FIRED AT 1000°C: Description
Can 1 5.93%	Cryst. kaolinite	Muscovite including sericitic muscovite	Tourmaline Quartz	Feldspar Zircon	Pale crimson pink Pl. XXIX 13″ f.	Coloring is due largely to iron-stained mica.
Can 2 2.70%	Cryst. kaolinite	Muscovite including sericitic muscovite	Tourmaline Quartz	Feldspar Zircon	Pale crimson pink Pl. XXIX 13″ f.	Coloring is due largely to iron-stained mica.
Can 3 18.08%	Cryst. kaolinite	Sericitic muscovite	Tourmaline	Quartz Spar	Pale pinkish cinnamon Pl. XXIX 15″ f.	Coloring is due largely to iron-stained mica.
Can 4 32.40%	Cryst. kaolinite	Sericitic muscovite		Tourmaline Quartz	White, very good	A trace of iron-stained mica is present.
Overflow 40.78%	Mostly cryst. kaolinite					

TABLE II—ENGLISH CHINA CLAY

Sample	Raw Clay: Essential Minerals: Very abundant	Raw Clay: Essential Minerals: Considerable	Raw Clay: Accessory Minerals: Small amounts	Raw Clay: Accessory Minerals: Trace	Clay Fired at 1000° C: Color	Clay Fired at 1000° C: Description
20–65M* 0.04%	Quartz	Kaolin Muscovite			Black Brown & white	
65–100M 0.04%	Kaolinite		Muscovite	Quartz	Black Brown & white	
100–200M* 0.17%	Kaolinite		Muscovite	Quartz	Dark vinaceous drab Pl. XLV 5″ i.	Coloring is due largely to iron-stained particles of kaolin and quartz.
Can 1 4.00%	Cryst. kaolinite			Quartz Biotite Spar Zircon	Pale pinkish cinnamon Pl. XXIX 15″ f.	Coloring is due largely to iron-stained particles of kaolin and quartz.
Can 2 6.37%	Cryst. kaolinite		Muscovite Tourmaline	Quartz Biotite Spar	Pale pinkish cinnamon Pl. XXIX 15″ f.	Coloring is due largely to iron-stained particles of kaolin and quartz.
Can 3 16.15%	Cryst. kaolinite		Muscovite Tourmaline	Zircon Quartz Biotite Spar	Pale pinkish buff Pl. XXIX 17″ f.	Coloring is due largely to opaque particles which have a tan color in reflected light.
Can 4 15.58%	Cryst. kaolinite				Best white color	Characterized by the absence of colored particles.
Overflow 57.67%	Mostly cryst. kaolinite					

*20–65M stands for that material which passes a 20 mesh sieve and is caught on a 65 mesh sieve. 65–100M and 100–200M also refer to the sieves used.

TABLE III—1.37. WHITE CLAY FROM DRY BRANCH, GEORGIA

Sample	Raw Clay: Essential Minerals		Raw Clay: Accessory Minerals		Clay Fired at 1000°C	
	Most abundant	Considerable	Small amounts	Trace	Color	Description
Can 1 5.95%	Cryst. & "colloid." kaolinite	Muscovite	Quartz	Zircon Rutile	Cartridge buff tinge Pl. XXX 19″ f.	Buff tinge is due to particles of iron-stained kaolin and colloidal matter. Cryst. kaolin appears white and translucent. Colloidal kaolin appears white and opaque. Muscovite appears transparent and iridescent.
Can 2 2.60%	Cryst. & "colloid." kaolinite	Muscovite		Quartz Zircon Rutile	Pale vinaceous fawn tinge Pl. XL 13″ f.	Buff tinge is due to particles of iron-stained kaolin and colloidal matter.
Can 3 6.60%	Cryst. & "colloid." kaolinite		Muscovite	Quartz Zircon Rutile	Tilleul buff tinge Pl. XL 17″ f.	Buff tinge is due to particles of iron-stained kaolin and colloidal matter.
Can 4 10.35%	"Colloid." & cryst. kaolinite			Muscovite	White with a cartridge buff tinge Pl. XXX 19″ f.	Characterized by the absence of colored particles.
Overflow 74.50%	"Colloid." kaolinite with small amts. of cryst. kaolinite			Muscovite	White with a cartridge buff tint Pl. XXX 19″ f.	Characterized by the absence of colored particles.

TABLE IV—1.38. WHITE CLAY FROM DRY BRANCH, GEORGIA

Sample	Raw Clay: Essential Minerals, Most abundant	Raw Clay: Essential Minerals, Considerable	Raw Clay: Accessory Minerals, Small amounts	Raw Clay: Accessory Minerals, Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
> 20M 37.2%	Quartz	Muscovite Kaolinite	Spar Biotite		Speckled brown, dark green & white	Red color is due to iron stained quartz. Greenish color is due to mica.
20–65M 4.0%	Quartz Kaolinite	Muscovite	Plagioclase Biotite	Zircon Rutile Tourmaline	Speckled yellow, brown & white	Yellow & brown colors are due to iron-stained mica.
65–100M 1.7%	Quartz Kaolinite		Plagioclase Biotite Muscovite	Zircon Rutile Tourmaline	Speckled yellow, brown & white	Color is due largely to iron-stained mica.
100–200M 5.5%	Kaolinite Muscovite	Quartz		Plagioclase Biotite	Speckled yellow, brown & white	Color is due largely to iron-stained mica.
Can 1 3.68%	"Colloidal" kaolinite Small amts. cryst. kaolinite			Zircon Muscovite	Pale vinaceous tawn Pl. XL 17″ f.	Color is due largely to iron-stained mica.

TABLE IV—1.38. WHITE CLAY FROM DRY BRANCH, GEORGIA (*Continued*)

Sample	Raw Clay: Essential Minerals		Raw Clay: Accessory Minerals		Clay Fired at 1000°C	
	Most abundant	Considerable	Small amounts	Trace	Color	Description
Can 2 2.00%	"Colloidal" kaolinite Small amts. cryst. kaolinite			Muscovite Biotite	Best white tinge of tilleul buff Pl. XI, 17″ f.	Characterized by the absence of colored particles.
Can 3 3.81%	Dirty "colloidal" kaolinite Small amts. cryst. kaolinite			Muscovite Biotite	Pale olive buff Pl. XI, 21″ f.	Color is due to numerous black particles some of which are included in kaolin.
Can 4 12.60%	Dirty "colloidal" kaolinite with traces of cryst. kaolinite			Muscovite	Pale olive gray Pl. I,I 23″″ f.	Color is due to numerous black particles some of which are included in kaolin.
Overflow 29.45%	Dirty "colloidal" kaolinite					

TABLE V—1.40. WHITE CLAY FROM DRY BRANCH, GEORGIA

Sample	Raw Clay: Essential Minerals		Raw Clay: Accessory Minerals		Clay Fired at 1000°C	
	Most abundant	Considerable	Small amounts	Trace	Color	Description
Can 1 10.85%	"Colloid." & cryst. kaolinite		Zircon Biotite	Muscovite Sericitic muscovite	Marguerite yellow Pl. XXX 23″ f.	Coloring is due to biotite, and black inclusion in colloidal kaolin. Also many black particles of unknown composition are present.
Can 2 5.65%	"Colloid." & cryst. kaolinite		Biotite	Zircon Muscovite Sericitic muscovite Quartz	White with a tinge of Marguerite yellow Pl. XXX 23″ f.	Coloring is due largely to black particles in colloidal kaolin.
Can 3 10.85%	"Colloid." kaolinite		"Colloid." matter probably hydrated silica	Biotite Muscovite Sericitic muscovite	White with a tinge of pale olive buff Pl. XL 21″′ f.	Coloring is due largely to black and brown particles in colloidal kaolin.
Can 4 8.05%	"Colloid." kaolinite		"Colloid." matter probably hydrated silica	Muscovite	White with a tinge of pale olive buff Pl.XL 21″′ f.	Coloring is due largely to black and brown particles in colloidal kaolin.
Overflow 64.60%	"Colloid." kaolinite		"Colloid." matter probably hydraulic silica			

TABLE VI—1.39. WHITE CLAY FROM DRY BRANCH, GEORGIA

Sample	Raw Clay: Essential Minerals, Most abundant	Raw Clay: Essential Minerals, Considerable	Raw Clay: Accessory Minerals, Small amounts	Raw Clay: Accessory Minerals, Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
100–200M 0.12%	Cryst. & "colloid." kaolinite	Muscovite				
Can 1 0.47%	Cryst. & "colloid." kaolinite		Muscovite Quartz			
Can 2 1.30%	Cryst. & "colloid." kaolinite		Muscovite Quartz Brown "colloid."	Zircon Biotite Rutile	Cartridge buff tinge Pl. XXX	Color is due to brown particles of biotite, rutile, and colloidal matter.
Can 3 9.24%	Cryst. & "colloid." kaolinite		Muscovite Brown "colloid."	Quartz Zircon Biotite	Tilleul buff tinge Pl. XL 17″ f.	Color is due to brown particles of biotite, rutile, and colloidal matter.
Can 4 13.63%	Cryst. & "colloid." kaolinite		Muscovite Brown "colloid."	Quartz Biotite	Best white pale olive tinge Pl. XL 21″ f.	Color is due to brown particles of biotite, rutile, and colloidal matter.
Overflow 75.35%	Mostly "colloid." kaolinite					

TABLE VII—1.33. WHITE CLAY FROM CLAYMONT, GEORGIA

Sample	Raw Clay: Essential Minerals, Most abundant	Raw Clay: Essential Minerals, Considerable	Raw Clay: Accessory Minerals, Small amounts	Raw Clay: Accessory Minerals, Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
100–200M 0.7%	Cryst. & "colloid." kaolinite	Muscovite	Quartz Zircon Biotite Tourmaline	Rutile	Tilleul buff tinge Pl. XL 17″′ f.	Cream tinge is due to brown particles of biotite and brown colloidal matter. Kaolin appears white and opaque. Quartz appears white and translucent.
Can 1 6.83%	Cryst. & "colloid." kaolinite	Muscovite	Quartz Zircon Biotite	Rutile Tourmaline	Tilleul buff tinge Pl. XL 17″′ f.	Color is due to brown particles of biotite and colloidal matter.
Can 2 2.20%	Cryst. & "colloid." kaolinite		Muscovite Quartz Zircon Muscovite	Rutile Tourmaline Biotite	Tilleul buff tinge Pl. XL 17″′ f.	Color is due to brown particles of biotite and colloidal matter.
Can 3 10.68%	Cryst. & "colloid." kaolinite			Biotite Zircon	Best white	Characterized by the absence of colored particles.
Can 4 22.60%	"Colloidal" & cryst. kaolinite			Muscovite Biotite Zircon	Tilleul buff tinge Pl. XL 17″′ f.	Color is due to iron-stained kaolin.
Overflow 57.00%	"Colloid." kaolin Small amts. of cryst. kaolinite					

TABLE VIII—1.23. WHITE CLAY FROM BUTLER, GEORGIA

Sample	Raw Clay: Essential Minerals, Most abundant	Raw Clay: Essential Minerals, Considerable	Raw Clay: Accessory Minerals, Small amounts	Raw Clay: Accessory Minerals, Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
100–200M 0.97%	Muscovite kaolinite	Quartz			Cartridge buff tinge Pl. XXX 19″ f.	Color is due to biotite which appears black and brown. Quartz appears translucent. Cryst. kaolin appears white and translucent. Colloidal kaolin appears white and opaque. Muscovite is transparent and iridescent.
Can 1 6.33%	Cryst. & "colloid." kaolinite Muscovite	Quartz	Zircon Black Opaque Unknown	Rutile Tourmaline Biotite	Ivory yellow tinge Pl. XXX 21′ f.	Color is due largely to black and brown biotite.
Can 2 37.90%	"Colloid." & cryst. kaolinite	Muscovite	Quartz Black Opaque Unknown	Rutile Tourmaline Biotite	Best white	Characterized by the absence of colored particles.
Can 3 6.91%	"Colloid." & cryst. kaolinite	Muscovite	Quartz Black Opaque Mineral	Biotite	Vinaceous fawn tinge Pl. XL 13″′ f.	Color due to particles of iron-stained kaolin and colloidal matter.
Can 4 4.42%	"Colloid." & cryst. kaolinite			Muscovite	Vinaceous fawn tinge Pl. XL 13″′ f.	Color is due to particles of iron-stained kaolin and colloidal matter.
Overflow 43.40%	"Colloid." kaolinite Small amts. of cryst. kaolinite					

TABLE IX—1.07. WHITE CLAY FROM JACKSON COUNTY, N. CAR.

Sample	Raw Clay: Essential Minerals		Raw Clay: Accessory Minerals		Clay Fired at 1000°C	
	Most abundant	Considerable	Small amounts	Trace	Color	Description
Can 1 12.0%	Cryst. kaolinite		Quartz Feldspar	Zircon Biotite	Tilleul buff tinge Pl. XL, 17″ f.	The coloring is due largely to iron-stained mica.
Can 2 15.29%	Cryst. kaolinite	Muscovite	Quartz Feldspar	Biotite	Tilleul buff tinge Pl. XL, 17″ f.	Coloring is due largely to iron-stained mica.
Can 3 18.93%	Cryst. kaolinite	Muscovite	Quartz Feldspar	Biotite	Tilleul buff tinge Pl. XL, 17″ f.	The coloring is due to a large number of particles varying from yellow to red and black. The reddish brown particles are iron-stained mica.
Can 4 12.25%	Cryst. kaolinite	Muscovite	Quartz		Tilleul buff tinge Pl. XL, 17″ f.	The coloring is due to iron-stained mica and yellow to black unknown.
Overflow 39.80%	Cryst. kaolinite					

TABLE X—1.41. WHITE CLAY FROM DILLSBORO, N. CAR.

Sample	Raw Clay: Essential Minerals, Most abundant	Raw Clay: Essential Minerals, Considerable	Raw Clay: Accessory Minerals, Small amounts	Raw Clay: Accessory Minerals, Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
20M 38.60%	Quartz Kaolinite	Muscovite Biotite Feldspar			Pink & brown	
20–65M 7.08%	Quartz Kaolinite	Muscovite Biotite Feldspar			Brown & white	The brown color is due largely to iron-stained mica.
65–100M 0.65%	Quartz Kaolinite	Muscovite Biotite	Feldspar		Brown & white	The brown color is due largely to iron-stained mica.
100–200M 5.80%	Cryst. kaolinite	Biotite	Quartz Muscovite Feldspar		Brown & white	The brown color is due largely to iron-stained mica.
Can 1 11.85%	Cryst. kaolinite		Biotite Quartz	Feldspar Muscovite	Pale vinaceous fawn Pl. XL 13″ f.	The brown color is due largely to iron-stained mica.
Can 2 5.78%	Cryst. kaolinite		Biotite Quartz	Feldspar Muscovite	Pale vinaceous fawn Pl. XL 13″ f.	The brown color is due largely to iron-stained mica.
Can 3 7.94%	Cryst. kaolinite			Biotite Muscovite Quartz	Pale vinaceous fawn Pl. XI 13″ f.	The coloring is due to iron-stained mica.
Can 4 5.70%	Cryst. kaolinite			Biotite Muscovite Quartz	Pale vinaceous fawn Pl. XL 13″ f.	The coloring is due to iron-stained mica.
Overflow 17.15%	Cryst. kaolinite					

TABLE XI—1.20. WHITE CLAY FROM LANGLEY, S. CAR.

Sample	Raw Clay: Essential Minerals: Most abundant	Raw Clay: Essential Minerals: Considerable	Raw Clay: Accessory Minerals: Small amounts	Raw Clay: Accessory Minerals: Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
100–200M 1.00%	Kaolinite					
Can 1 2.63%	"Colloid." & cryst. kaolinite		Rutile Zircon Muscovite "Colloid." Unknown	Quartz Tourmaline Biotite	White	Many brown particles are present, probably hematite
Can 2 11.21%	"Colloid." kaolinite Small amounts cryst. kaolinite		"Colloid." Unknown	Tourmaline Zircon Rutile	White very good	Brown particles are present due to hematite and iron-stained mica.
Can 3 22.74%	"Colloid." kaolinite Small amts. cryst. kaolinite		"Colloid." Unknown	Zircon	Best white	Characterized by the absence of colored particles.
Can 4 24.38%	Mostly "colloid." kaolinite				Very good white	Very few colored particles present.
Overflow 38.85%	Dirty "colloid." kaolinite				Light vinaceous fawn, Pl. XL 13″d.	Color is due largely to many brown particles, apparently hematite.

TABLE XII—1.14. WHITE CLAY FROM LANGLEY, S. CAR.

Sample	Raw Clay: Essential Minerals, Most abundant	Raw Clay: Essential Minerals, Considerable	Raw Clay: Accessory Minerals, Small amounts	Raw Clay: Accessory Minerals, Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
Can 1 12.05%	"Colloid." & cryst. kaolinite		Quartz	Muscovite including sericitic muscovite Zircon Rutile	Tilleul buff tinge Pl. XL, 17″ f.	Color is due largely to iron-stained mica and hematite.
Can 2 7.40%	"Colloid." & cryst. kaolinite			Quartz Muscovite	Tilleul buff tinge Pl. XL, 17″ f.	Color is due largely to iron-stained mica and hematite.
Can 3 1.65%	"Colloid." kaolinite Small amts. of cryst. kaolinite			Quartz Muscovite	Tilleul buff tinge Pl. XL, 17″ f.	Color is due largely to iron-stained mica and hematite.
Can 4 10.90%	"Colloid." kaolin Small amts. cryst. kaolinite			Muscovite	Tilleul buff tinge Pl. XL, 17″ f.	Color is due largely to iron-stained mica and hematite.
Overflow 68.0%	Mostly "colloid." kaolinite					

TABLE XIII—1.62. WHITE CLAY FROM SAYLORSBURG, PA.

Sample	Raw Clay: Essential Minerals: Most abundant	Raw Clay: Essential Minerals: Considerable	Raw Clay: Accessory Minerals: Small amounts	Raw Clay: Accessory Minerals: Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
20–65M 0.9%	Kaolinite	Quartz			Light mouse gray Pl. Ll 15‴′ b	Coloring is due largely to impurities in quartz and kaolin aggregates.
65–100M 0.66%	Kaolinite	Quartz			Light mouse gray Pl. Lz 15‴′ b	Coloring is due largely to impurities in quartz and kaolin aggregates.
100–200M 4.20%	Kaolinite		Quartz		Smoke gray Pl. XLVI 21‴ d	Coloring is due largely to impurities in quartz and kaolin.
Can 1 2.62%	Cryst. kaolinite Small amts. "colloid." kaolinite		Zircon Quartz Tourmaline Black Unknown	Biotite Muscovite	Tilleul buff Pl. XL 17‴ f.	Coloring is due largely to impurities in quartz and kaolin. Iron-stained mica and hematite are also present.
Can 2 2.94%	Cryst. kaolin Small amts. "colloid." kaolinite		Zircon Quartz Muscovite Black Unknown	Biotite Tourmaline	Pale olive buff Pl XL 21‴ f.	Coloring is due to brown particles of iron-stained quartz, kaolin and mica. Hematite is also present.
Can 3 10.50%	Cryst. & "colloid." kaolinite		Quartz Black Unknown	Biotite Muscovite Zircon	Cartridge buff Pl. XXX 19‴ f.	Coloring is due largely to iron-stained mica and hematite.
Can 4 14.13%	Cryst. & "colloid." kaolinite		Black Unknown	Biotite	Cartridge buff Pl. XXX 19‴ f.	Coloring is due largely to iron stained mica and hematite.
Overflow 64.40%	Mostly "colloid." kaolinite		Black Unknown		White very good	Characterized by the absence of color.

TABLE XIV—1.74. WHITE CLAY FROM SAYLORSBURG, PA.

Sample	Raw Clay: Essential Minerals, Most abundant	Raw Clay: Essential Minerals, Considerable	Raw Clay: Accessory Minerals, Small amounts	Raw Clay: Accessory Minerals, Trace	Clay Fired at 1000°C: Color	Clay Fired at 1000°C: Description
Can 1 10.06%	Cryst. kaolinite	Quartz	Tourmaline		Light mouse gray Pl. LI 15″′ b.	Coloring is due largely to impurities in kaolin aggregates.
Can 2 8.03%	Cryst. kaolinite	Quartz	Tourmaline		Pale olive buff tinge Pl. XL 21″ f.	Coloring is due largely to impurities in kaolin aggregates.
Can 3 13.45%	Cryst. kaolinite		Quartz	Tourmaline Zircon	Pale olive buff tinge Pl. XL 21″ f.	Coloring is due largely to impurities in kaolin aggregates.
Can 4 19.58%	Cryst. kaolinite			Quartz Tourmaline	Tilleul buff tinge Pl. XL 17″ f.	Coloring is due largely to iron-stained kaolin.
Overflow 48.50%	Mostly cryst. kaolinite					

Discussion

H. RIES: I have read Mr. Schurecht's paper with great interest, the more so because in some work undertaken for the United States Geological Survey, we had a microscopic examination made of over 100 samples of clay, the results of which have already been published in condensed form.[1] In this work a study was made not only of the raw clay, but also samples fired to 1150°C and 1300°C.

Two minerals that were almost universally present were kaolinite and hydromica. The latter name was applied to certain distinctly micaceous grains, which showed single and double refraction higher than kaolinite, but not so high as muscovite or sericite. The degree of these refractions varied in the different clays, and it was assumed that there is an isomorphous graduation between sericite and kaolinite, with a gradual loss of potash and the addition of water, and that in weathering products such as these the hydromica represents a transition stage of weathering towards kaolinite as the final product.[2]

In the samples of white clay from Georgia which were examined it was noticed that on the average, kaolinite was usually abundant; hydromica, common; quartz, scarce; zircon and rutile, scarce.

The white clays from South Carolina showed kaolinite to be abundant; hydromica, common; quartz, variable; rutile, fairly common; zircon, scarce.

The white residual clays from the Saylorsburg district of Pennsylvania had kaolinite in abundance; hydromica in moderate to abundant quantity; quartz, common to abundant; rutile usually abundant; zircon, tourmaline, epidote and titanite, scarce.

Some rather interesting changes occurred in the firing. Thus at 1150°C the hydromica as shown by a study of thin sections either disappeared forming an isotropic mass, or else it lost the greater part of its interference color. The only exception was

[1] Somers, R. E., "Microscopic Examination of Clays," *Jour. Wash. Acad. Sci.*, **9**, 113 (1919).

[2] See also Calpin, S. L., "Studies of Flint Clays and Their Associates," *Trans. Amer. Ceram. Soc.*, **24**, 306 and 338; also Hickling, G., "China Clay. Its Nature and Origin," *Trans. Inst. Min. Engrs.*, **36**, 1908–1909; Also *Econ. Geol.*, **15**, 243 (1920).

where the hydromica grains were much larger than usual, in which case it was noticed that the central portion of the grains retained the original interference color.

Kaolinite when not fluxed, appeared to retain its shape or at least a good part of its interference color.

Tourmaline and probably epidote seemed to disappear at 1150°C but rutile, zircon, and probably titanite seemed unaffected even at 1300°C.

Sillimanite was identified in a Florida white clay fired at 1300°C and had apparently formed from large flakes of kaolinite and hydromica, as was indicated by composite flakes of sillimanite and one of the other two minerals.

It seems not unnatural, as mentioned by Mr. Schurecht, that the Georgia and South Carolina white clays should be fine-grained, and contain a larger quantity of colloidal matter, than the north Carolina kaolins since they have been more exposed to water action, and this fact has been previously emphasized by N. B. Davis.[1]

[1] "The Plasticity of Clay and Its Relation to Mode of Origin," *Trans. Amer. Inst. Min. Engrs.*, vol. II, p. 451, 1916.

CERAMIC EXPERIMENTAL STATION
U. S. BUREAU OF MINES
COLUMBUS, OHIO

A LOW FIRE PORCELAIN[1]

By Charles F. Binns and Tina Burdick

ABSTRACT

Pieces of the following composition were cast and then fired at about cone 02, or lower, and then glazed and fired at cone 4. The result was a pleasing porcelain.

Frit Batch: Whiting, 0.32 × 100 = 32; Niter, 0.28 × 202 = 56.5; Borax, 0.12 × 328 = 45.8; Soda Ash, 0.18 × 106 = 19; Magnesite, 0.10 × 84 = 8.4; Calcined Clay, 0.24 × 222 = 53.3; Flint, 1.8 × 60 = 108; Total=322. Georgia Clay 0.07 or 18 parts was added to the fritted batch

The object of this study was to produce a porcelain at the temperature of cone 4, somewhat after the fashion of the French Pâte Tendre, but a once-fired ware.

The glaze was to be made without lead oxide. As there was no known mineral which would produce vitrification under this heat treatment it was decided that the body must contain a frit. It was thought possible that the glaze might be built upon the same frit.

The first frit made up corresponded to the following formula:

Na_2O	0.3	Al_2O_3	0.55	SiO_2	2.88
MgO	.4				
K_2O	.5				

In order to introduce the high content of alumina it was decided to use cryolite, Na_3AlF_6, which it was expected would reduce the solubility of the melted frit. The frit, as made, ran through the drop furnace fairly well but it was found that 9.6 percent was soluble in water. A change was therefore made as follows:

Formula of Second Frit

Na_2O	0.3	Al_2O_3	0.40	SiO_2	3.42
MgO	.5				
K_2O	.2				

This proved to be more satisfactory, the solubility being reduced to 4.2 percent.

[1] Received Oct. 11, 1921.

The batch weights of frit are: cryolite 126, magnesite 42, feldspar 165, flint 90.

The feldspar used was rather impure, corresponding to the formula K_2O, 1.5 Al_2O_3, 9.6 SiO_2, with the weight of 825.

A diagram of twenty-one body mixtures was then made on the triaxial frame using the three following bodies as apices.

	No. 1	No. 2	No. 3
North Carolina Clay	10	40	..
English China Clay, MGR 1	10	..	40
Feldspar	20	10	20
Flint	30	30	30
Frit	..	20	10
Ball Clay J.P. 9	30	..	..

No body in the series was found to be satisfactory so that a new series was made as follows:

	No. 4	No. 5	No. 6
English China Clay, MGR 1	40	40	50
Feldspar	..	30	15
Flint	30	30	20
Frit	30	..	15

Numbers 4 and 6 offered desirable possibilities and a series of four was made between them.

	A	B	C	D
No. 4	0.8	0.6	0.4	0.2
No. 6	.2	.4	.6	.8

Body D proved to be fairly satisfactory and was found to contain: English china clay, MGR1 48, feldspar 12, flint 22, frit 18.

A batch of this mixture was made up and ground but upon casting the pieces they were found to be very brittle and difficult to handle. The mixture was therefore changed to: English china clay, MGR1 40, Georgia clay 6, feldspar 12, flint 20, frit 22.

Tests were made of this and it was found to work much better. The body was white and fine grained but it was still tender and had to be handled carefully.

The body was ground in a ball mill, the charge being 500 grams. It was ground in enough water to make it an easily flowing slip and was not washed when taken from the mill. It was kept in slip form at the consistency of a good casting slip and allowed to stand at least three days before using. Two-tenths of a gram of cobalt sulphate were added to one thousand grams of clay for a bleach.

Glaze tests were then made using the following two formulae and the body frit as the third member, the triaxial plot of twenty-one members being followed.

Glaze A

CaO	0.60	Al_2O_3	0.25	SiO_2	2.65
K_2O	.20	B_2O_3	.30		
Na_2O	.20				

Glaze B

CaO	0.40	Al_2O_3	0.25	SiO_2	2.65
K_2O	.30	B_2O_3	.30		
Na_2O	.30				

Glaze C (Body Frit)

Na_2O	.30	Al_2O_3	.40	SiO_2	3.42
MgO	.50				
K_2O	.20				

Clay to the amount of 0.07 was added in the mill. Glaze 17 contained 0.8 of B and 0.2 of C and proved to be the best.

Formula of Glaze 17

CaO	0.32	Al_2O_3	0.31		
K_2O	.28	B_2O_3	.24	SiO_2	2.42
Na_2O	.30				
MgO	.10				

Batch

Whiting	.32×100=32	Magnesite	.10× 84=8.4
Niter	.28×202=56.5	Calcined Clay	.24×222=53.3
Borax	.12×328=45.8	Flint	1.8 × 60=108
Soda Ash	.18×106=19	(Total)	322

Georgia clay 0.07 or 18 parts was added to the fritted batch.

It will be noted that the plan of using the body frit as a glaze basis was not carried through. The glazes which contained this frit were not good.

The pieces were cast and then fired at about cone 02 or lower to harden them. They were then glazed and fired at cone 4.

The result was a pleasing and even beautiful porcelain, having a good deal more of the true porcelain character than the early soft porcelains. Under-glaze colors were used with some success in decoration.

ALFRED UNIVERSITY
ALFRED, NEW YORK

THE DEGREE TO WHICH DIFFERENT GLAZE COMPOSITIONS TAKE VAPOR LUSTERS[1]

By R. T. Watkins

ABSTRACT

Glazes having an oxygen ratio of approximately 3 to 1, a medium or low acid content with a B_2O_3 to SiO_2 ratio of approximately 1 to 2.5 and high in lead and low in lime, take the best vapor luster effects.

Introduction

The iris or mother-of-pearl luster resembles, as the name indicates, the iridescence or play of colors observed in sea shells. The luster of pearls[2] is due to minute indulations of the edges of alternate layers of carbonate of lime and membrane, which impart a beautiful iridescent sheen, ranking pearls with the best of gems.

Mother-of-pearl iridescence[3] on glass ware and pottery is produced by providing one or more transparent to translucent thin layers of suitable composition over the surface of the glass or glaze. Light is reflected from both the upper and lower surfaces of such layers. Variations in thickness and successive layers are found most favorable for reflecting back certain colors and for cutting off other colors, especially complimentary colors. This gives a more or less regularly banded series of prismatic colors, while a layer of strictly uniform thickness gives a single uniform color.

Iridescent decorations on glassware[4] have been made for some time, but the process is accompanied by many difficulties when applied to pottery, as was formerly brought out by Weiskopf,[5] the first to make the process generally known. Weiskopf used

[1] Received August 3, 1921. Published by permission of the Director U. S. Bureau of Mines.

[2] T. Wodiska, "Book of Precious Stones."

[3] Ashley, *Trans. Am. Ceram. Soc.*, **7** (1905).

[4] Ashley, *Ibid.*, **7** (1905).

[5] Wagner's *Jahresbericht* and Stohman Kerl's *Dictionary*.

the following mixture which he introduced into a muffle kiln containing the ware to be irised, the temperature being at a red heat: 1 part barium carbonate, 0.5 part strontium carbonate, 2.0 parts tin salt ($SnCl_4$). This mixture produces a vapor which when coming in contact with the ware, produces a mother-of-pearl effect, strontium giving red, barium blue and stannic chloride various colors.

The composition of the glaze has very much to do with the ability of the vapor luster to produce the iridescent effect, and for this reason the writer selected three different groups of glazes, each group having the following variations; (1) variation in oxygen ratio, OR; (2) variation in the B_2O_3 to SiO_2 ratio; (3) variation in the lime and lead content.

Preparation

The three groups chosen were:[1]

1.	Group I	O R	0 in acids	6
			0 in bases	1
2.	Group II	O R	0 in acids	4.5
			0 in bases	1
3.	Group III	O R	0 in acids	3
			0 in bases	1

These groups were chosen because they represent a considerable variation in SiO_2, B_2O_3, PbO and CaO contents. 0.2 equivalent Al_2O_3 was maintained constant in all the glazes of this study.

The following rules were observed in making up the frits: (1) All the RO was included; (2) all the Al_2O_3 except 0.05 equivalent; (3) all the SiO_2 except 0.4 equivalent. The frits were mixed thoroughly and melted in a gas fired crucible frit kiln. No difficulty was met with in melting them. They were wet ground, evaporated to dryness and passed through a 100 mesh screen. Blending was done dry. The test pieces used were biscuit whiteware tile.

[1] Whitmer, J. D., *Trans. Amer. Ceram. Soc.*, **11**, 262(1909). "A Study on the Production of Opalescence in Highly Acid Glazes." Groups 7, 4 & 1—for convenience will call 1, 2 and 3 in the following.

The glazes were applied to a thickness of about $^1/_{16}$ of an inch and fired to cone 10 in a gas fired test kiln.

Procedure in Irising

The glazed tile were placed in a small electric furnace near the top and heated to a temperature of 700°C. They were held there for $^1/_2$ hour, whereupon enough of the following mixture:

Barium Nitrate.....	2 parts
Strontium Nitrate.....	1 part
Stannic Chloride.....	3 parts
Bismuth Nitrate.....	0.5 part
Sulphur.....	1 part

was strewn upon the floor of the furnace to fill it with thick vapors. The furnace was then shut off and the contents allowed to cool. If the glazes become matt, it may be either due to too strong heating or to too much iris salts. Metallic specks are produced if the iris preparation is brought too near the object to be irised. Too weak a luster is produced, either if the objects are not hot enough or if iris salts are insufficient. Finally, an excess of bismuth nitrate in the mixture was found to blacken the objects, causing the mother-of-pearl effect to be obscured

Results of Work

The results of the work are shown in detail in the charts (see Tables 1, 2 and 3). A few general deductions can be drawn from a study of the results. It is observed first, that those glazes which have a medium or low acid content can be given the best mother-of-pearl effects. Second, that high lead and low lime seem to be conducive to better results. Third, in glazes having a low acid content, a B_2O_3 to SiO_2 ratio of 1:2 and 1:2.5 gives the best effects.

GROUP I

$$O:R \begin{cases} O \text{ in acids} \\ O \text{ in bases} \end{cases} = \frac{6}{1} Al_2O_3 \text{ Eqv.} = 0.2$$

	R O Content				Series 1 Ratio 1:2		Series 2 Ratio 1:2.5		Series 3 Ratio 1:3		Series 4 Ratio 1:4		Series 5 Ratio 1:5	
	K_2O	Na_2O	CaO	PbO	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2
A	0.15	0.15	0.40	0.30	1.3714	2.7430	1.2000	3.000	1.0667	3.1830	0.8727	3.4908	0.7384	3.6922
					Poor		Poor		Fair		Poor		Fair	
B	.15	.15	.50	.20	.3714	2.7430	.2000	3.000	.0667	3.1830	.8727	3.4908	.7384	3.6922
					Poor		Fair		Poor		Poor		Poor	
C	.15	.15	.60	.10	.3714	2.7430	.2000	3.000	.0667	3.1830	.8727	3.4908	.7384	3.6922
					Poor		Poor		Poor		Poor		Poor	
D	.15	.15	.70	.0	.3714	2.7430	.2000	3.000	.0667	3.1830	.8727	3.4908	.7384	3.6922
					Fair		Poor		Poor		Fair		Poor	

TABLE 1

GROUP II

$$O:R \begin{cases} \text{O in acids} \\ \text{O in bases} \end{cases} = \frac{4.5}{1} Al_2O_3 \text{ Eqv.} = 0.2$$

	R O Content				Series 1 Ratio 1:2		Series 2 Ratio 1:2.5		Series 3 Ratio 1:3		Series 4 Ratio 1:4		Series 5 Ratio 1:5	
	K_2O	Na_2O	CaO	PbO	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2
A	0.15	0.15	0.40	0.30	1.0286	2.0571	0.9000	2.250	0.8000	2.3915	0.6545	2.6182	0.5538	2.7692
					Good		Good		Poor		Fair		Poor	
B	.15	.15	.50	.20	.0286	2.0571	.9000	2.250	.8000	2.3915	.6545	2.6182	.5538	2.7692
					Poor		Good		Good		Fair		Poor	
C	.15	.15	.60	.10	.0286	2.0571	.9000	2.250	.8000	2.3915	.6545	2.6182	.5538	2.7692
					Poor		Poor		Good		Fair		Poor	
D	.15	.15	.70	.0	.0286	2.0571	.9000	2.250	.8000	2.3915	.6545	2.6182	.5538	2.7692
					Poor		Poor		Poor		Poor		Poor	

TABLE 2

GROUP III

$$O:R \begin{cases} O \text{ in acids} \\ O \text{ in bases} \end{cases} = \frac{3}{1} Al_2O_3 \text{ Eqv.} = 0.2$$

	R O Content				Series 1 Ratio 1:2		Series 2 Ratio 1:2.5		Series 3 Ratio 1:3		Series 4 Ratio 1:4		Series 5 Ratio 1:5	
	K_2O	Na_2O	CaO	PbO	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2	B_2O_3	SiO_2
A	0.15	0.15	0.40	0.30	0.6857	1.3714	0.60	1.50	0.5333	1.60	0.4364	1.7456	0.3692	1.846
					Excellent		Excellent		Good		Good		Good	
B	.15	.15	.50	.20	.6857	.3714	.60	.50	.5333	.60	.4364	.7456	.3692	.846
					Excellent		Good		Good		Good		Fair	
C	.15	.15	.60	.10	.6857	.3714	.60	.50	.5333	.60	.4364	.7456	.3692	.846
					Good		Fair		Fair		Fair		Poor	
D	.15	.15	.70	.0	.6857	.3714	.60	.50	.5333	.60	.4364	.7456	.3692	.846
					Fair		Poor		Poor		Poor		Poor	

TABLE 3

A CONVENIENT INSTRUMENT FOR MAKING SHRINKAGE MEASUREMENTS[1]

By W. C. Broga and C. J. Hudson

ABSTRACT

See Figure 1.

A characteristic of most clays is a shrinkage which takes place when fired; a study of clays infers a study of shrinkages.

Convenient clay samples for shrinkage determinations can be made up in the shape of discs. By means of the instrument described in the following paragraphs, discs can be quickly and accurately measured both before firing and after, and the percentage shrinkage readily determined.

Figure 1 is a photograph of the instrument. It consists of an iron casting, A, upon which is mounted the disc B; the disc is attached to a small shaft running through its center and is mounted in a ball bearing. Attached to the periphery of the disc B is a rather stiff fine wire, C, which runs from B through the perforated guides D_1 and D_2, thence around the disc E, through the perforated guide D_3 and finally to the clamp F. By rotating the disc B in a clockwise direction the wire is brought tightly around the disc E; by a suitably attached pointer, G, a reading may be obtained on the scale at the extreme right. By stretching the wire tightly the disc E is always brought up against the stop H which should be so adjusted that the parts of the wire between D and F, except that which encircles the disc E, will be collinear. The instrument is mounted on legs at the back which give it an inclination of about forty-five degrees downward toward the operator. The weight of the pointer G keeps the wire taut.

The method of measurement is to first raise the pointer G, thus rotating the disc B in a counter-clockwise direction, loosening the wire C thereby enlarging the loop around E; while held in this position, a new disc is inserted in the wire loop, the pointer is allowed to drop, the wire is brought tightly around the new disc, and a reading made on the scale.

[1] Received Oct. 13, 1921.

If the discs have been made in the same mold, presumably their prefired measurements will be alike and the pointer, by means of the adjusting screws I and clamp J, can be brought to read zero. The scale may be so graduated as to read centimeters of circumference shrinkage, or, as in the present case, it may be graduated to read directly in percentage of circumference shrinkage.

The instrument described is equipped with a number of small devices which add greatly to its usefulness. The arm K is actuated by a spring, thereby always insuring that the discs are against

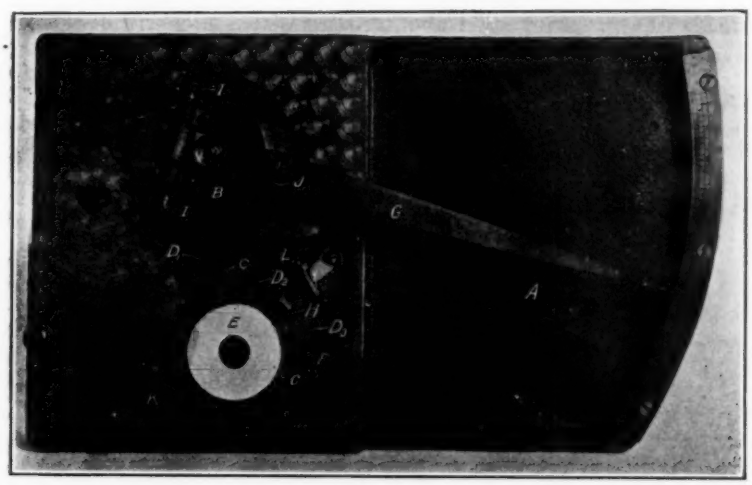

FIG. 1.

The construction and principle of operation are evident from figure 1.

the stop H, or against the other stops indicated, if large discs are used. The dog L holds the pointer up while new discs are inserted into the wire loop. The arm K and the stops are grooved in such a way that as the wire loop is expanded, the wire is held in the grooves which guide it around the periphery of the newly inserted disc.

Discs of the Veritas type may be used to good advantage in studying the heat distribution inside a kiln; a large number may be set with the ware without encroaching upon kiln space. After

drawing, these discs can be measured, their shrinkages determined, and the relative heat distribution within the kiln studied. Where large numbers of discs are used for this purpose such an instrument greatly facilitates the measurements.

An instrument similar to the one described can be readily made in a small machine shop. Figure 1 is an illustration of the one in use at Norton Company. The main casting A is 10 $\times$ 17″ and from $^1/_8$″ to $^1/_4$″ thick; legs about 5″ long are attached to the back so as to give the main casting an inclination of about 45° toward the user. The disc B is 4″ in diameter and the pointer G is 12″ long, the length of the scale is about 8″. The wire used is made of stiff spring steel about 20 gauge. The instrument will measure discs up to 3″ in diameter.

NORTON COMPANY
WORCESTER, MASS.

OPERATION OF LEERS[1]

C. E. Frazier

ABSTRACT

The *muffle* and *open types of leers* are compared. The latter has the following advantages: (1) More uniform temps. in the annealing chamber; (2) prevents ingress of cold air beside pans and thus avoids consequent cracking of the ware; (3) better control of temp. and greater reliability of pyrometric indications; (4) less fuel per gross of ware.

Size of leers: Leers 8 ft. wide and 65 ft. from center to center of sprockets are recommended for the average glass.

Leer chains: Chains having a working strain of 5800 lbs. at 200 ft. per minute are recommended.

In the discussion, L. H. Adams points out that the *exact annealing schedule* required for any glass can be computed from the annealing constants of the glass which are known or can be determined in the laboratory.

The object of this discussion is to bring out the essential factors that enter into the proper annealing of glass articles rather than to discuss the technical side of the question, and in order to treat the matter intelligently, we must first determine the causes of annealing troubles.

The purpose of the leer is to remove the strains in glass articles which are necessarily introduced during the manufacturing operations. Since the plungers and the molds must be maintained at a temperature lower than that of the glass the conditions in the pressing operation are favorable for the production of strain and it is obvious that the greater the difference in temperature between the glass and the mold or the plunger, the greater will be the strain from this source. After removing from the mold the article is further chilled until it may be carried to the leer without distortion, but if this chilling is allowed to proceed too far, for example, through negligence of the carrying-in boy, the strains are unduly increased and the annealing is thereby made more difficult. The size, shape and weight of the article are

[1] Received March 17, 1921.

also important factors which determine the quantity of the strain produced and which must be considered in the operation of the leer.

To remove these strains it is necesssary to raise the temperature of the article to a point which is higher than that at which the strains were created, and to maintain this temperature (soak) for a sufficient time to allow the glass to become thoroughly and uniformly heated. After this it must be cooled gradually to a temperature below which strains can not be introduced by rapid cooling. Experience has shown that the initial temperature of the annealing chamber should be from about 800°F to 1100°F (425°C to 595°C), and that the time necessary for "soaking" is from forty-five minutes to one hour twenty minutes, depending on the shape and weight of the article and on the method of manufacture. The exact conditions in the leer can be determined only by experience with the article to be annealed.

Even though the temperature and treatment in the hot end of the leer be correct, the ware may easily be destroyed by incorrect treatment as it passes through the leer. It is not uncommon to observe ware, which has been "melted down" in the hot end, coming through the leer in a broken condition. This indicates that the temperature of the hot end was high enough to remove the strains and that at some point after leaving the hot end, the article was cooled too rapidly. This may result from a draft of cold air or from cold pans. To eliminate these disturbing conditions in the open type of leer it has been customary to apply auxiliary heat underneath the pans, and while this method has improved annealing, it has been quite expensive from a fuel standpoint and at the same time has caused rapid depreciation of the pans. This heat under the pans serves another purpose than that mentioned above: it causes more uniform temperature in the annealing chamber and consequently results in better annealing.

To properly anneal any piece of glass, the following conditions are necessary: proper mold design, proper working temperatures, proper temperature in annealing chamber, proper "soaking" time, and gradual cooling of ware after it leaves the hot end of the leer. This latter condition is very necessary on any type of leer, whether open or muffled, continuous, or hand pulled pan type.

The muffled leer has many advantages over the open type, some of which are as follows: more uniform temperature in the annealing chamber, elimination of the cold air coming up by the side of or between the pans, better control of temperature, and greater capacity.

While a muffle leer will use more fuel than an open leer, it has been thoroughly demonstrated that the cost of fuel per gross of ware is less than with an open leer. Another feature that is of great importance in the packer's trade is that a muffle leer eliminates the necessity for the washing of the ware, when operated with raw producer gas. There are several designs of muffle leers on the market any of which will give better annealing than the open leer.

A very common trouble with the open leer is that the pyrometer couple is invariably placed in the center of the crown extending through the brickwork a few inches. It is a well known fact that in such a position the pyrometer will register a higher temperature than the temperature at the pans, and this difference is dependent entirely on the height of the crown and the kind of a flame employed. This temperature has been known to vary as much as 250° and it has been found that by changing the location of the couple so as to give a more nearly correct record of the temperature at the pans, breakage was practically overcome.

In one instance in the writer's experience, the pyrometer couple extended through the crown of the leer and the pyrometer indicated a temperature of 1200°F while the pan temperature was 800°F owing to the fact that the couple was so placed as to receive the direct heat from the flame. After changing the couple so that the pyrometer indicated the correct temperature, and increasing the temperature of the annealing chamber, the trouble was overcome.

Another experience worth mentioning was an investigation for the purpose of overcoming breakage on fruit jars which had stood what is known as the hot water test. It was proved that this trouble was caused by a drop of 200° to 250° in the first arch back of the fire box and it was entirely overcome by reducing this drop in temperature to about 75°. It has been found that the correct rate for cooling ware is obtained with a temperature

drop of about 50° to 60° for every five feet after the ware leaves firebox until it reaches a temperature of about 350°F, after which time rapid cooling does not harm, and with some classes of ware rapid cooling from 500°F is permissible.

The correct length of the leer has been a matter of controversy for years. After a very careful study, it has been decided that 65 feet from center to center of sprockets is sufficient for the annealing of the average glass, although there are exceptions. In one installation a 65 foot leer was built along side of an 80 foot leer and after a year's operation on the same kind of ware, the owner cut fifteen feet from the 80 foot leer and purchased two more 65 foot leers which makes his equipment now stand four (4) 65 foot muffled leers.

Experiments have been made with leers 5, 6, 7, 8, 9, and 10 feet wide and it has been concluded that the 8 foot leer gives more real satisfaction than any other width. The reasons for this are as follows: It gives more uniform temperatures in the annealing chamber than wider leers, has more mechanical strength than wider leers and is also more flexible. It is needless to state that different shaped articles as well as articles of different weight require different treatment and it is therefore not advisable to attempt to anneal articles differing considerably in shape and weight together in the same leer. Experience has shown that three 7 foot leers are preferable to two 10 foot leers and four 8 foot leers are better than three 10 foot leers. The reason we recommend 8 foot leers is because an 8 foot leer costs very little more than a 7 foot leer and gives practically the same flexibility and uses no more fuel.

We had a client a little over a year ago who had installed three 5 foot hand pulled leers of the open type and had installed an automatic feeder which greatly increased his production. He wished to install a continuous leer but these could not be installed on account of the time limit. We therefore arranged to muffle his old leers to give him the capacity required while the new leers were being manufactured, and much to our surprise he annealed successfully in these 3 leers 400 gross of milk bottles in 24 hours and accomplished it more satisfactorily than he had been able to anneal 250 gross in the open leers.

Any of you who have had experience with continuous leers have no doubt had the annoyng experience of the leer chain pulling in two after the leers had been in use for a year or two. This results, first from side loading the chain, and second because the chain is too light for the work in question. After it has been subjected to the heat for some time it becomes too weak for the duty it has to perform and eventually breaks.

The chain used on the first continuous leers had a working strain of 2000 lbs. at 200 feet per minute; the next chain was of 2300 lbs. working strain at the same speed; and the next was a chain of 3600 lbs. at the same speed, but a change in design of the leer caused side loading on the chain, which, investigation proved, reduced the safe working strain by 50%. This meant, in effect, a weaker chain than the original and although the design was greatly improved, the chain was too weak to withstand the strains which caused the continual breaking of the chain. Chains now in use have a working strain of 5800 lbs. at 200 feet per minute and we have never heard of one pulling in two.

Discussion

By L. H. Adams.—This paper is an interesting account of some of the factors connected with glass-annealing, and such discussions as Mr. Frazier's are valuable aids in the design of leers.

It would seem, however, that in considering the principles underlying the annealing of glass, it is essential to take account of the physical nature of the annealing of glass. In the first place it is desirable to adopt some standard of annealing, that is, the maximum amount of strain (in definite units) that can be tolerated in the given class of ware. In the second place the problem of glass-annealing can be dealt with intelligently only by starting with the known (or determinable) annealing-constants of the particular kind of glass used. When the constants of the glass are known, it is a very simple matter to determine in advance exactly the temperature-cycle to be followed. The annealing-process naturally divides itself into two stages: first, the existing strain must be removed, and next, the glass must be cooled in such a way that the new strain introduced does not

exceed the allowable limit. There are several ways by which this may be done. The glass may be heated to the temperature at which strain disappears almost instantaneously (about 550° C for ordinary soda-lime glass) and then cooled slowly. Or, on the other hand, the glass may be heated to a lower temperature for a longer time and then cooled at a much faster rate than by the first method. The second method is the better one for reasons which, for lack of space, it is not possible to enumerate at this time.

As indicated by Mr. Frazier, below a certain temperature the cooling may be much more rapid. This is true no matter what kind of a temperature cycle is used. Below about 400° for ordinary soda-lime glass and about 300° for lead glasses the permanent strain is not influenced by the speed at which the glass is cooled, and hence below these temperatures the cooling rate is limited mainly by what the glass will stand without breaking as it is cooled.

The calculation of the maximum cooling rate is one of the simplest of problems. The rate is inversely proportional to the square of the thickness and for a sheet of glass $^1/_2$ inch thick is 80°C per minute. In the later stages of the cooling, therefore, cooling may be *regular*, *i. e.*, it is not sufficient that the average rate be within the limit specified; the rate at any moment must be below the given amount.

Finally it should be noted that the statement "It is necessary to raise the temperature of the article to a point which is higher than that at which the strains were created" is meaningless for the reason that strain is not created at any particular temperature. Actually the strain makes its appearance at comparatively low temperatures, its amount being (mainly) determined, however, by the cooling rate of the glass at the higher temperatures, *i. e.*, by the rate throughout a certain range, which for ordinary soda-lime glasses is between 400° and 550°C.

SIMPLEX ENGINEERING CO.
WASHINGTON, PA.

THE COST SYSTEM AS AN AID TO EFFICIENT PLANT CONTROL[1]

By Dwight T. Farnham

ABSTRACT

A cost system for a clay plant is described, by means of which complete records are kept of the condition of the plant each day as compared with an established standard. The results of such a system are a more perfect understanding between superintendent and general manager as to the actual factory conditions and increased efficiency in plant control. Graphic charts keep the information before the executives and workmen alike, thus leaving no one in ignorance of the progress of the work as compared with the established standard.

In the past too many cost systems have been devised by bookkeepers and not enough by executives. As a result the majority of cost systems provide for everything balancing to the third decimal place about seven weeks after the history of events, which the figures record, began to happen. Usually about the twenty-first of February the General Manager receives "news" as to what happened January first. Under the circumstances we can not blame him for being bored and throwing the carefully prepared figures aside for a trip through the works.

The trip through the works is quite as unsatisfactory a method of controlling the efficiency of operation as the cost system. There is too much element of chance about what is encountered. Some superintendents are born lucky and always throw the last of a bad kiln over the dump just as the General Manager arrives. Others are less fortunate and the sight of fourteen men drawing a kiln with post-mauls and steel crow bars is always a sure sign that the General Manager has just entered the front gate.

Furthermore a good many superintendents have learned to be "tactful." Bitter experience has shown them that under the usual methods of works control they are judged by the front they put up. They therefore combine with a study of the boss'

[1] Received March 10, 1921.

likes and dislikes a specious optimism and lead the weekly executive procession from point to point of safe interest, with all the enthusiasm and mendacity displayed by the professional guide in Rome or Naples. And the General Manager is usually about as helpless as the average American tourist under the same circumstances.

It may be that the incompetent or dishonest superintendent is eventually separated from the field of his endeavors by the evidence which accumulates against him on the cost sheet. But under the historical method there is too much opportunity for loss before the fire department is notified. Furthermore after seven weeks the evidence in the case is so scattered to the four winds that the opportunity to profit by an expensive lesson is lost. And finally with such scraps of evidence as exist, all in the hands of the defendants, it is not surprising if they find occasional alibis easier than continuous, efficient plant operation.

Just as long as General Managers are content to manage their properties by basing their decisions upon opinion rather than upon fact, just so long will incompetent factory executives continue to "get by." And it is more the fault of the Manager than of the superintendents and foremen. If no one has taught you how to collect facts or how to draw the correct inference from such facts, and if the management has refused to spend any money for the collection of such facts as you have timidly suggested might be valuable, you can not be blamed if you meet such crises as arise with "facts" manufactured upon the spur of the moment. Furthermore, if you have been expected to know what is going on inside a kiln instinctively and to remember what went on inside some forty other kilns at each stage of each burn and to compare the results in each case with the causes which produced them in such a way as to profit by spoiled kilns and to reproduce every exceptionally fine burn during the past year—you have not much respect for the manager who thought he could get that sort of a brain for a hundred and fifty dollars a month and you conclude that what he does not know will not hurt you.

The remedy is of course the collection of facts in the form of immediate, adequate and accurate records and a cost system either devised, or criticised in detail, by an executive of actual exper-

ience in the details of manufacture. I know of one case where a well known public accountant worked out a uniform cost system for a branch of the clay industry and proposed saving clerical work by counting only the spoiled ware which came from the kilns! This was not only bad accounting but bad psychology. He provided no check on the setting reports,—he was asking the kiln crew to tell on themselves whenever they smashed anything—and the factory foreman in charge of the crew to hang himself if he were incompetent. In as much as such crews—both drawing and setting—are paid mostly on a piece work basis, by failing to provide a check on the amount set, he was just begging the men to sweeten their tally sheets and so secure some easy money at the company's expense.

To operate a clay plant at all effectively the superintendent and the General Manager should have at least the following records daily—

1. Output from the machines and moulders in tons or thousands as compared to standard output.
2. Quantity. Set and drawn as compared to standard.
3. Quantity. Shipped.
4. Percentage of first quality, seconds and lost ware drawn from each kiln with detailed explanation of causes when firsts fall below an established standard.
5. Drier loss in percentage of output, by products.
6. Number of men at work in each department and the total tons produced per man per day.
7. Efficiency of operation of each department expressed in terms of a definite percentage of actual accomplishment to realizable standards set.
8. Coal and clay on hand as compared with a minimum standard set. (Careful inventory not required unless supply falls below standard.)
9. Machine shut-downs by departments in terms of percentages of possible running time.

This infomation should be entered on graphic charts in the factory control office in such a way as to make what is accomplished each day comparable with past performances and with standards. Past performances may be carried in the form of

monthly averages and a cumulative curve should be carried showing the effect of each day's performance on the month to date.

For the use of the burners very complete records should be maintained in comparable form showing the progress of each burn and the results obtained.

Where the workmen in the various departments are paid in proportion to results obtained—which implies both quantity and quality of production—records of how nearly they approach standard earnings should be kept in such a way that men who are not regularly earning standard wages may be helped to do so.

These records as outlined require the establishment of standards of production. If this has not been done, the daily study of what is happening from day to day is alone of considerable value. However—if you do not know what you *ought* to be able to do, it is difficult for you—or anyone else—to judge how well you *are* doing.

From these reports monthly records and charts should be prepared and placed in binders upon the desks of the Superintendent and of the General Manager.

The actual production costs are of course prepared only once a month but it is comparatively easy to have the factory costs ready within two days of the close of the month, since the cumulatives referred to, provide for the gathering of the production data as the month progresses and a properly designed distributon sheet provides for the money distributed against the various products manufactured each day in each department being checked daily against the pay roll. As a result it is only necessary on February 1st to add in the distribution for January 31st and you are ready to divide the dollars by the quantities. The same plan followed in regard to supplies and raw materials makes it possible to have the operating costs ready for a conference between the Superintendent and his department heads on the second, and a written report to the General Manager in which exceptional conditions, either good or bad are explained, on the third. Factory costs then average two weeks old instead of three and a half weeks as is the case when they do not appear until the 21st of the month.

This course of procedure is comparatively easy for the Superintendent who is amply provided at all times with dependable facts and it takes up very little of the General Manager's time as compared with the old system. It promotes confidence on the part of both—since the Superintendent knows he is going to stand or fall upon a basis of what he *does*—instead of upon what he *says*—and the Manager knows he is getting the truth. Difficulties can be studied in the light of all the evidence while it is still hot and plans worked out to avoid a good many of these difficulties in the future. The whole organization is provided with the data necessary for intelligent decision and knows that whatever it does will be reflected in hard cold figures placed where everybody can see them. And there is no greater incentive to efficiency than the knowledge that you are to be rewarded exactly in proportion to your just deserts.

POROSITY: V. RECOMMENDED PROCEDURES FOR DETERMINING POROSITY BY METHODS OF ABSORPTION

By Edward W. Washburn and Elmer N. Bunting

ABSTRACT

Detailed Procedure.—For shaped test pieces details of the procedure are given under the headings, "Preparation of Test Piece," "Determination of Dry Weight," "The Absorption Apparatus," "Preparation of Standard Vaseline," "Saturation Procedure," "Calculation," and "True Density."

A Pycnometer Method.—A new and accurate method, which is applicable equally to shaped test pieces or to granular material, is described. Among other advantages it gives the operator control over the max. size opening which he desires to class as part of the pore space. It also can be made to indicate directly the necessary soaking period.

XIII. Preparation of the Test Piece and Determination of Its Dry Weight

43. Cleaning the Surface.—After the test piece has cooled to room temperature, its surface should be cleaned and smoothed and sharp corners and edges rounded as far as possible. Surface defects likely to conceal cavities should be opened with a knife or file so that the absorption liquid may be removed therefrom readily. In cleaning and smoothing the surface, the instruments and means employed will vary with the nature of the body. A stiff brush, a file, a sharp knife, a grindstone, sandpaper, etc., will all be found useful in different cases. The best one to employ in a given case must be left to the judgment of the individual. Obviously the method employed must not contaminate the test piece by filling its surface pores with any foreign material, nor must these surface pores be left filled with dust from the body itself. In the case of very soft, very porous bodies, a blast of air or a strong suction may be employed to advantage for freeing the body from dust. A final brushing of the surface with a good stiff brush may be recommended for most cases. If the surface

of the test piece is covered with a hard glassy skin, one or, better, both ends of the piece should be cut or broken off so as to expose an interior surface. With highly vitrified bodies it is frequently necessary to remove the total surface layer in order to obtain the correct porosity values for the body itself.

44. The Dry Weight.—Transfer the clean test piece to a desiccator and allow it to stand over 95 percent sulphuric acid until it has attained constant weight, W_d. The time required for this may be materially hastened by evacuating the desiccator. In any case a few hours will suffice.

XIV. Saturation of the Test Piece

45. The Absorption Apparatus.—Figure 5 shows a convenient type of absorption apparatus. The absorption vessel V may be made of a heat resisting glass with the cover ground to fit the flange F, or of metal and a gasket used on this flange. If constructed of glass, the vessel should be round-bottomed and supported on legs, or in a base as shown. An ordinary round-bottomed glass flask may be substituted for the vessel V if desired, provided its neck is wide enough to admit the test pieces.

The tube A connecting the vessel V with the flask D should be an all-glass connection, if the absorption liquid is something which attacks rubber (*e. g.*, benzene or kerosene); otherwise, a flexible rubber connection may be used. All ground-glass joints and stop-cocks should be accurately ground and well lubricated. A good lubricant for this purpose may be prepared by heating together pure rubber, vaseline, and paraffine in any proportions between 7–3–1 and 16–8–1. A sealing varnish, which can afterward be readily removed with a cloth moistened with ether, is made by melting together equal parts of beeswax and rosin. It is applied hot, with the aid of a small camels' hair brush, to any point where a leak is feared.

46. Preparation of Standard Vaseline.—Melt a considerable quantity of vaseline, filter to remove solid particles, and transfer to a vessel which can be heated and evacuated. Boil the vaseline *in vacuo* for six hours, and allow it to cool completely in the vacuum. Store in a dust-tight container.

Determine its specific gravity at the average and at the minimum and maximum room temperatures by proceeding exactly as described in Sec. 47 below, but with a calibrated specific gravity bottle substituted for the test pieces.

47. Saturation Procedure.—(1) Place the test pieces in the absorption vessel, put on the cover, and see that all joints are tight.

(2) Place enough of the saturating liquid in the flask D to fill the absorption vessel V well above the level of the test pieces.

(3) Insert the stoppers R and R′, close cock S_2 and open cock S_3.

(4) Connect C with the vacuum pump and evacuate until air ceases to be given off from the liquid in D. The liquid may be boiled to advantage for a few minutes, being heated if necessary.

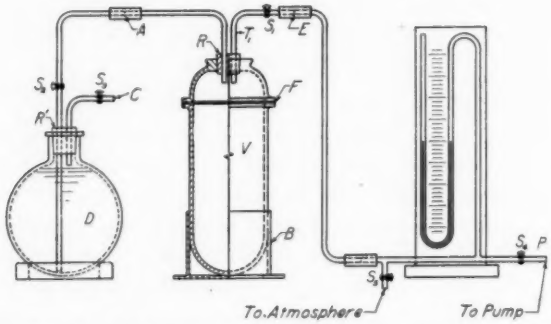

FIG. 5.—Apparatus for determining porosity by the vacuum saturation method.

(5) Close cock S_3, disconnect the pump from C and connect it to P.

(6) Open cock S_4, close S_5, and evacuate the absorption vessel until the manometer ceases to fall.

(7) Open S_2 and then S_3 *slightly* until the liquid in D rises and *just* fills cock S_2. Then immediately close S_2 and S_3 and continue the evacuation of V until, on closing S_4, the manometer shows a constant reading. This reading should be less than AB where B is the barometric pressure (in the same units as the manometer scale) and A is the fractional accuracy desired in the porosity.[35] If the pump employed will not give this degree of vacuum, then procedure 8*a* must be introduced.

[35] See Sec. 28 above.

(8) With S_4 closed, stop the pump, open S_2 and then S_3 until enough liquid has been forced into V to completely cover the test pieces. If the absorption liquid is too stiff to flow readily at room temperature, the flask D and the vessel V may be kept in a pan of hot water.

(8*a*) If the vacuum pump gives a vacuum better than *AB*, omit 8*a* and proceed directly to 9; otherwise, proceed as follows, if the absorption liquid is a pure liquid: With the pump running, S_2 closed and S_4 open, warm the liquid in V until it *boils*. Continue the boiling until the air has been completely removed from the pores. The boiling period necessary to accomplish this will vary with the nature of the ware, and must be ascertained by experiment. This may be done by returning the test piece to the absorption vessel after its saturated weight has been taken and repeating the boiling-*in-vacuo* treatment to see whether a gain in weight takes place.

(9) With S_2 closed, open S_5 thus breaking the vacuum. Allow the test pieces to soak for at least S minutes, S being given by the expression

$$S = \frac{S_o}{z/z_o} \tag{7}$$

where z/z_o is the relative penetrativity of the liquid at the soaking temperature employed, and S_o is, for the test pieces employed, the standard soaking period for water at 20°C. Values of $\frac{z}{z_o}$, for vaseline, at any temperature between 100° and 200°C may be computed from the relation

$$\left(\frac{z}{z_o}\right)^{1/2} = \frac{t-30}{480} \tag{8}$$

If the necessary soaking period for water is not known, an approximate calculation of a minimum S may be made from the relation

$$S = \frac{l^2}{rz} \tag{9}$$

where l is the maximum linear dimension of the test piece and r is the radius of the smallest pore which it is desired to fill. Values

of z for vaseline may be taken from equation 5. This calculation, however, gives only a value for S above which the actual minimum soaking time must lie.[36]

(10) When the soaking has been completed and the contents of V are at room temperature, remove the test pieces, one at a time, wipe with a cloth dampened with the absorption liquid, and weigh rapidly, W_s. If vaseline is employed, the test pieces may be scraped with a spatula and then wiped with a piece of chamois skin or other similar material.

Care should be taken not to warm the test pieces by contact with the hands. A weighing tube may be employed, if desired, to avoid vaporization losses during weighing.

(11) Suspend each test piece from a fine wire and weigh it (W_h) suspended in water (or any other suitable liquid) whose density at room temperature is D_w, the specific gravity of the absorption liquid at the same temperature being D_s.

$$\text{Percent porosity} = x = \frac{100\ (W_s - W_d)D_w}{(W_s - W_h)D_s} \qquad (10)$$

$$\text{Bulk density} = D_B = \frac{W_d\ D_w}{(W_s - W_h)} \qquad (11)$$

48. Determination of the True Density.—This determination can be most conveniently carried out on a separate sample of the material, but if it is desired to use the test piece employed in the porosity measurements, the saturation liquid must first be removed from its pores. With water or other pure liquid, this should be effected by low temperature drying *in vacuo*, followed, if desired, by a short calcination at a temperature considerably lower than that at which the test piece was drawn in its previous firing.

If vaseline has been employed as the saturation liquid, the test piece should be crushed, the vaseline removed by washing with benzene or gasoline and then with naptha, and the material dried as above.

The dried test piece is then powdered and the true density determined in the usual way.

[36] See Secs. 29 and 30 above.

XV. A Pycnometer Method for Determining Porosity by Absorption

49. Purpose of the Method.—The method discussed in the next few sections differs from those previously considered in that it is applicable equally to test pieces of standard shapes and dimensions and to irregular pieces or granular material. It has the further advantage that the operator may fix the dimension, dividing a pore from a hole or crack, at any size which he desires. The maximum surface-pore dimension is thus under complete control. The procedure involves a determination of the bulk density followed by a saturation experiment.

50. Procedure for Bulk Density.—A pycnometer of weight, W_P grams, capacity, V_P cc. (at the "setting" temerature), and having a form pequivalent to that shown in Fig. 6 is employed.

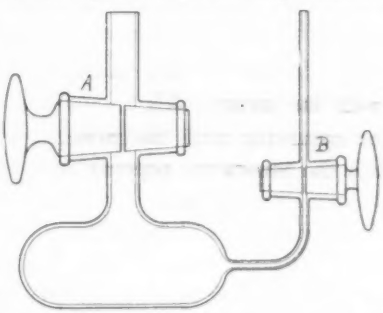

FIG. 6.—Combined volumeter and absorption apparatus for measuring the porosity of granular materials.

(1) Fill the bulb of the pycnometer with a coarsely granular, sieved, and dried sample of the material and weigh, W_1.

(2) Evacuate the apparatus through A until the pressure falls to less than $\frac{ABV_B}{V_P}$, where B is the barometric pressure, A is the fractional accuracy desired in the result, and V_B is the bulk volume of the sample of material.

(3) Admit mercury through B until the apparatus is full and the mercury level in A is some distance above the stop-cock.

(4) Close B and adjust the vacuum until, at room temperature, the manometer reading plus the distance h (from the center of the bulb to the mercury level in A) is equal to $0.05/d$ cm., where d is the diameter in cm. of the largest opening which it is desired to class as a *pore*, all larger openings being classed as *holes* or cracks.

(5) Close stop-cock A, disconnect the pump, and remove all mercury from above both stop-cocks. Then open A or B and weigh the pycnometer and its contents, W_2.

(6) Calculate the bulk density D_B of the material.

$$D_B = \frac{(W_1 - W_P)\, D_M}{D_M\ V_P - W_2 + W_1} \qquad (12)$$

where D_M is the density of mercury at the temperature of operation 4.

51. Saturation Procedure.—(7) Remove the contents of the pycnometer, separate the sample of material from the mercury, *completely*, and return it to the pycnometer; or, if desired, take a new sample of the material for this determination. Weigh the pycnometer with the sample W'_1.

(8) Evacuate the apparatus until the pressure is not greater than AB where B is the barometric pressure and A is the fractional error permissible in the result.

(9) Admit the absorption liquid until the apparatus is full. Water may be used for this liquid, if it is without action upon the material, otherwise carbon tetrachloride, benzene or any other suitable *pure* organic liquid may be employed.

(10) With stop-cock A closed and B open, allow the apparatus to stand at room temperature, $t'°$, for the necessary soaking period. Then close B, remove all excess liquid from above both stop-cocks, and weigh, W'_2.

(11) Calculate the percent porosity.

$$\text{Percent porosity} = x = 100\,[1 - \frac{(D_L V_P - W'_2 + W'_1) D_B}{D_L\ (W'_1 - W_P)} \qquad (13)$$

where D_L is the density of the absorption liquid at the temperature $t'°$.

52. Theory of the Method.—One obvious advantage of the pycnometer method is the approximately quantitative control which it gives over the size of surface opening which is to be classed as pore space. The pressure necessary to force mercury into a pore opening of diameter d, is equal to $\frac{4\gamma \cos\theta}{d}$ where γ

is the surface tension and θ the angle of contact. For mercury, $\gamma \cos \theta$ may be taken as 165 dyne/cm. at room temperature and hence the above expression is equal to $\frac{0.05}{d}$ cm. of Hg, where d is expressed in cm.

Thus for example, if we wish to class as *holes* or *cracks*, all openings larger than 0.1 mm., and as pores, all openings smaller than this, then the pressure in the pycnometer at the time of closing stop-cock B in operation (5) above should be $\frac{0.05}{0.01} = 5.0$ cm. of Hg. The value of d which is chosen will be determined by the character of the material and the purpose of the porosity determination, but an important feature of the pycnometer method is that this quantity is under experimental control.

In using the pycnometer method it is essential that the pieces of the sample employed should be approximately uniform in size and should not be too small, otherwise some of the space between particles would not be filled by the mercury and the result obtained would represent the porosity of the mass of material in the pycnometer rather than that of the body represented by the sample. The *minimum* allowable size is determined somewhat by the value chosen for d, the maximum pore diameter. The *maximum* size for the pieces of the sample is evidently determined only by the size of the neck of the pycnometer.

Owing to the fact that in operation (4) the apparatus functions as a rather sensitive thermometer it is evidently very easy to ascertain when temperature equilibrium has been attained.

For a similar reason operation (10) indicates the necessary soaking period which should be allowed, that is, the soaking period may be assumed to be over as soon as the meniscus in the small tube is falling at a negligibly small rate.

It is also evident that by graduating the small tube above stop-cock B it is possible to obtain considerable information about the character of the pores present in the material. Indeed, by controlling the pressure under which the liquid enters the pores of the material, one may determine the total pore volume of those pores having effective diameters between any two stated

limits, and may thus classify the total porosity into groups of given pore size, and may determine what fraction of the total belongs within each class. Such a study could, however, best be carried out with mercury, the method being a static one.[37] For the smallest pores high pressures would, of course, be required.

(*To be continued*)

[37] See Washburn, E. W., "Note on a Method of Determining the Distribution of Pore Sizes in a Porous Material.," *Proc. Nat. Acad. Sci.*, **7**, 115 (1921).

Vol. 1 JANUARY, 1922 No. 1

Ceramic Abstracts

EDWARD W. WASHBURN, Editor
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ABSTRACTORS: E. N. BUNTING; W. M. CLARK, G. S. FULCHER, S. L. GALPIN, A. T. MALM, R. J. MONTGOMERY, LOUIS NAVIAS, C. W. PARMELEE, C. M. SAEGER, JR., H. G. SCHURECHT, R. B. SOSMAN, H. F. STALEY, E. W. TILLOTSON.

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General and Miscellaneous

1. Glimpses of Ohio ceramic industries. I. CHESTER H. JONES. *Chem. Met. Eng.*, **25**, 562–66(1921).—Ohio holds first place among the states in the production of ceramic wares, producing about 24 percent of the total annual output of claywares in the U. S. General descriptions are given of the processes used in making chem. stoneware at the plant of the U. S. Stoneware Co. at Akron and in making common stoneware at the plant of Ramsbottom Bros.' Pottery Co. at Roseville. H. F. S.

2. Fine grinding. No. 2. The influence of the shape of the particle. L. G. HILL. *Trans. Ceram. Soc.*, **19**, 3–13(1920).—It is stated that the Griffin mill has proven satisfactory for preliminary grinding of pottery materials when followed by magnetic separation of iron particles and wet pan grinding. H. F. S.

PATENTS

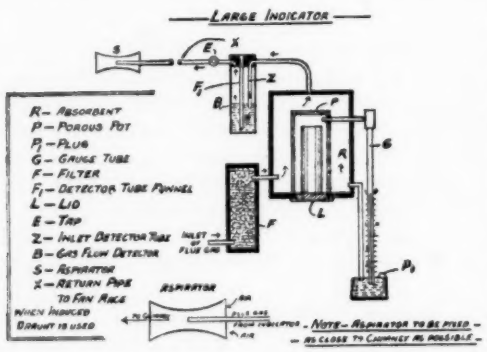
3. Alkali silicates. F. J. PHILIPS and E. J. ROSE. Brit. 151,339, June 19, 1919. In order to obtain a sol. alkali silicate of high silica content, the product obtained by the fusion of alkali and silica is dissolved in H_2O and an acid then added, whereby gelatinous silicic acid is thrown down, and this ppt. by continued agitation is made to redissolve in the soln. The acid, preferably H_2SO_4, may be added in the form of spray; and after the subsequent operation of agitation or grinding, the soln. may be evapd. to dryness. Moreover, to increase the fusibility of the alkali and silica, a little borax may be employed in the fusion process. (*C. A.*)

4. Process for treating clay. JOHN H. RYAN. U. S. 1,385,716, July 26, 1921. The process of treating clay consisting first, in breaking the same into small lumps and then drying in the presence of heat for the purpose of a preliminary oxidization, mixing with a surplus of water to settle out any grit, adding thereto ammonia to neutralize any acid in the clay, introducing the pulp into a pebble mill to grind the same and to thoroughly admix the ammonia therewith, next adding a bleaching agent, of one-half of one percent of the water content, and continuing the action of the pebble mill for a period of substantially two hours to fully admix the chem. therewith and secure its action, thereafter diluting the pulp to draw the same from the mill and subjecting it to an agitator to entirely dissolve and remove the chem. settling, and decanting the water, withdrawing the pulp and filtering the same, and subjecting the thick pulp to a drying action to finish the product. C. M. SAEGER, JR.

5. Dry-kiln. JOSEPH F. HIRT. U. S. 1,385,451, July 26, 1921. A kiln having a drawing chamber and a heating chamber; means for circulating air through the chambers; means whereby fresh air is admitted to the circulating air at a point where it will pass through the heating chamber before entering the kiln chamber, thereby thoroughly mixing and heating the additional fresh air with the recirculating air, before entering the drying chamber; means for supplying humidity to the air before it enters the drying chamber; and means for varying the amt. of humidity supplied to various portions of the kiln. C. M. SAEGER, JR.

Apparatus and Instruments

6. Scientific control of combustion. H. T. RINGROSE. *J. Iron and Steel Inst.* (Adv. copy No. 8), 9 pp. (1921); *Engineering*, **111**, 565–66; *Engineer*, **131**, 511–12; *Iron and Coal Trades Rev.*, **102**, 628–29.—An app. and a method are described for recording automatically and continuously the *amt. of CO_2 in flue gases* by measuring on a manometer tube the amt. of vacuum obtained in a porous pot containing a soda-lime absorber and surrounded by an atm. of flue gases, the amt. of vacuum produced depending solely on the % of absorbable gas surrounding the pot. It measures very small amts. of CO_2 even that in ordinary air or about 0.04%. The quickness or responsiveness of the indication depends solely on the porosity of the pot. The app., as shown in the figure, consists of an aspirator connected to the flue under observation, a filter and a chamber contg. the porous pot, inside which is the dry absorbing reagent. A pipe connects the chamber with a vessel of water, into which dips one end of a graduated tube, the other end being extended into the porous pot. As soon as absorption begins, the vacuum produced and the % of CO_2 are read off directly. Another similar app., the W. R. Producer CO_2 Indicator, has been devized for measuring *the CO_2 in producer gas.* For neutralizing the effect of the H another similar pot is provided with a dummy cartridge with no absorbent and H is passed through setting up in both pots opposing diffusion pressures; the difference in reading on the manometer tube is proportional to the per cent of CO_2 in the mixt. It is accurate to within 0.0–0.6% as compared with an Orsat app. This affords a direct and scientific control of producer gas quality. Attempts are being made to design an instrument so sensitive as to show variations in CO_2 in a water-gas plant from second to second instead of the av. over a certain period. J. L. WILEY (*C. A.*)



7. The Avrutik continuous and automatic shifting process for separating liquids and solids. JOSEPH AVRUTIK. *Louisiana Planter*, **66**, 379–80(1921).—A design of the app. and description of the principles involved are given. Three centrifugal baskets placed one above the other, and permitting an overflow for solids from the upper basket into the lower baskets, are the principle features of the app. The material under treatment can be washed as desired. C. H. CHRISTMAN (*C. A.*)

8. New testing machines. II. Hardness testing machines. E. IRION. *Z. Ver. deut. Ing.*, **65**, 315–20(1921).—Five new instruments for measuring

the *hardness of metals*, four by the Brinell method and one by the Martens-Heyn method, are described. F. P. FLAGG (*C. A.*)

9. The Atkins centrifugal filter press. ANON. *Caliche*, **2**, 148(1920).—The advantages which the rotation of the filtering medium is stated to give are: (1) Continuous elimination of the solids from the filter cloth by the centrifugal action due to the rotating filter disks. (2) The solid materials are deposited in the form of a paste on the walls of the container. (3) The filtered soln. discharges immediately and does not accumulate. (4) Either pressure or vacuum may be used. (5) Discharge of the solid materials is continuous. The app. (of which drawings are given) consists in principle of several circular filtering disks mounted on a shaft which may be rotated, the whole being enclosed in a tank or container to which pressure may be applied.

C. L. BURDICK (*C. A.*)

10. Drying stoves scientifically designed. B. J. ALLEN. *Trans. Ceram. Soc.*, **19**, 26–41(1920).—A description of the conveyor type of pottery dryer now used in the U. S. A. H. F. S.

11. A new centrifugal filter press. C. R. PLATZMANN. *Tonind. Ztg.*, **45**, 1081–82(1921).—A new centrifugal filter press made by Stancourt, Son's and Muir Ltd., London, is described. The substance to be dewatered is fed into the center of the centrifuge which rotates at about 45 revolutions per sec. and the slip is thrown with great force (1 kg. per cm.^{2}) against a filtering medium. The dewatered clay is thrown against the outside of the centrifuge while the water is forced out below. When the chamber inside of the centrifuge has become filled with clay the operation is stopped until same has been removed. This is done by raising the outer shell. This takes about 2 min. and 2 men can operate 4 filter presses. The coarse material is separated from the fine in this filter press which for certain purposes is an advantage. This press requires less space than others and permits the use of high pressures.

H. G. SCHURECHT

12. Uehling carbon dioxide recorder. ANON. *Engineering*, **111**, 626–27 (1921).—A const. flow of flue gas is drawn through a chamber containing an absorbing medium. The CO_2 in the stream is absorbed and the resulting change in pressure is recorded by a manometer graduated directly in per cent CO_2. 4 illus. H. BUTTLER (*C. A.*)

PATENTS

13. Thermocouple for high-temperature measurement. T. TAKIZAWA, J. TSUKAMOTO AND TOKYO DENKI CO. Japan 36,602. June 15, 1920. A couple is made of W and Mo wires, enclosed in a porcelain tube, which is maintained in vacuum or filled with H or A, perferably H at $^2/_3$ atm. It is used for the interval 1500–1850°. The e. m. f. of this couple increases proportionately to the increase of temp. at low-temp. interval; thermoelectric inversion occurs at 530°; the e. m. f. decreases, reaching zero near 1300° and changes direction. The e. m. f. in mv. is as follows: 1500° 2.82; 1600° 3.49; 1700° 4.25; 1800° 5.20; 1900° 6.20. (*C. A.*)

BOOK

14. Pyrometry: A practical treatise on the measurement of high temperatures. CHARLES R. DARLING. 2nd ed. revized and enlarged. 240 pp. 10s 6d net. For review see *J. Inst. Metals*, **25**, 484(1921). (*C. A.*)

See also No. 26.

See also No. 38.

Chemistry, Physics and Geology

15. On a hitherto unknown copper aluminate of the spinel type. J. ARVID HEDVALL AND JOSEF HEUBERGER. *Z. anorg. allgem. Chem.*, **116**, 137(1921).—CuO and Al_2O_3 in the mol. ratios 1:1, 1:2, and 2:1 were heated with 6 to 10 times their wt. of KCl at 850° for an hour and also without KCl at 900° for one week. Microscopical examn. indicated that the product from the 1 : 1 mixt. was homogeneous. The products purified by digestion with dil. HNO_3 to remove excess of CuO or Al_2O_3 yielded a brown powder, the compn. of which corresponded to $CuO.Al_2O_3$. The powder consisted of fairly well formed cubes and octahedra. A study of by-reactions observed when KCl was used as a flux is being made. W. E. T.

16. On the binary systems of lithium orthosilicate with zirconium orthosilicate and calcium orthosilicate. ROBERT SCHWARZ. *Z. anorg. allgem. Chem.*, **115**, 87(1921).—The system Li_4SiO_4–$ZrSiO_4$ was investigated thermally and optically from Li_4SiO_4 up to a compn. containing 70 mol. percent $ZrSiO_4$. A max. in the m. p. curve was found at the compn. $2Li_4SiO_4-3ZrSiO_4$ and a eutectic at 30 mol. percent $ZrSiO_4$. Since no mixed crystals were formed it was possible to calc. the mol. wt. of $ZrSiO_4$ from the lowering of the m. p. This was found to correspond to the simple formula $ZrSiO_4$. The system Li_4SiO_4–Ca_2SiO_4 was investigated up to 60 mol. percent $CaSiO_4$. The m. p. curve is a complicated one indicating mixed crystal formation and showing a max. at 40 mol. percent and 60 mol. percent Ca_2SiO_4. At lower temps. (about 932°) a molecular rearrangement takes place which indicates the formation of the compd. $Li_4SiO_4.Ca_2SiO_4$. The density data and the optical examination support this conclusion. E. W. T.

17. The measurement of the consistency of varnish. H. A. GARDNER AND P. C. HOLDT. Paint Mfgrs. Assoc. of U. S., *Circ.* **127**, 51 pp. (June 1921).—The authors define viscosity, plasticity, rigidity, and viscous and plastic flow. Abs. viscosities obtained with the Bingham variable pressure plastometer (*C. A.*, **14**, 1047) fitted with a modified receiver, on 37 different varnishes of various types ranged from 0.6 to 5.5 poises at 25°; these are tabulated against results obtained with the MacMichael and Doolittle torsion viscometers. Details of the operation of the instruments, calcn. of the capillary const. of the plastometer, discussion of accuracy, etc., are given. The MacMichael operated at accurately controlled low speeds and temp., might be used for research and routine work but it is not as accurate as the plastometer and exhibits a tendency to indicate viscosities lower than the true values. The Doolittle appears best adapted for routine testing although its readings can not

be calcd. to abs. viscosities. The Stormer and the Hadfield-Bawtree (*C. A.*, **15,** 180) viscometers are described. The occurrence of plasticity in varnishes can not well be explained on the hypothesis of solid friction, because ultramicroscopic examn. shows very few solid particles; but it may be due to emulsoid aggregates forming a continuous structure through the varnish.

F. A. WERTZ (*C. A.*)

18. Molecular force and plasticity of clays. HERBERT CHATLEY. *Trans. Ceram. Soc.*, **19,** 1–2(1920).—Suggestion is made that plasticity (and also, when the molecules of the fluid are considered, the specific "colloid" properties of sub-divided matter) is due to the presence of molecular forces comparable with wt. or other external agency. H. F. S.

19. Equilibria of hydrofluosilicic acid. LAWSON J. HUDLESTON AND HENRY BASSETT. *J. Chem. Soc.*, **119,** 403–16(1921).—The present accepted method of testing for silica in HF by adding KCl with formation of turbid K_2SiF_6 is found to be inadequate. A method of studying the compn. of mixts. of HF and H_2SiF_6 is found in the fact that for the complete neutralization of the latter acid, according to the equation $H_2SiF_6 + 6NaOH = 6MaF + H_2SiO_3 + 3H_2O$, an appreciable time is required. Thus when NaOH is added to the mixed acids the time may be measured from the moment of mixing till the color of the indicator (phenolphthalein) fades. Other additions of alkali are made until the color no longer fades. Since the total concn. of H ions is produced but slowly, they must be bound in a complex. If n cc. of alkali were originally present and N cc. were required for the total permanent neutralization $(N-n)/N\times100 = C$ is the percentage of total H ions in bound condition at the moment of fading. The various values of *log C* plotted against time give the straight line usual for a monomol. reaction, from which C_0, the original concn. of the complex present in the unneutralized acid, is calcd. The rate of dissoc. of Na_2SiF_6 into SiF_4 and NaF is detd. The effect of temp. upon the velocity const. is given by the equation $\log k = (-9662/T) + 29.83$. Equil. conditions demand that when SiF_4 is passed into H_2O a considerable proportion of unchanged SiF_4 should be present, and the H_2SiO_3 can exist in soln. with an active mass proportional to its concn. to the extent of at least 0.003 mols. per 1. at 15°. G. L. CLARK (*C. A.*)

20. Influence of surface tension on fusion and solidification. ERNST RIE. *Wien. Anz.*, **1920,** 137–39.—In connection with a communication by Pavlov (*C. A.*, **3,** 860) R. develops an expression for the dependence of the m. p. T_2, of small, cryst. granules on the surface tension, S_{23} (free energy of the surface), in the form $Tp - T_0 = -T_0 \times 2S_{23}/s_3rq$, where T_0 is the limiting m. p. (without reference to surface energy), s_3 the density of the solid phase, r the radius of the cryst. granules considered as spheres, and q the latent heat of fusion. This expression, which is derived from the Gibbs equil. conditions by purely thermodynamic reasoning, and is readily adapted to the case of a drop enclosed within a crystal, gives results differing from those of Pavlov. Further observations of the m. p. of crystals are necessary to decide which of the conditions,

$S_{13} \gtrless S_{12}+S_{23}$ is valid. Probably, the majority of amorphous substances are composed of extremely minute crystals, the size of the granules being $> 10^{-5}$ cm.; the absence of a definite m. p. is to be ascribed to surface tensions.

J. C. S. (*C. A.*)

21. Diffusion in silicate melts. N. L. BOWEN. *J. Geol.*, **29**, 295–317(1921).—In order to determine exptly. the rate of diffusion in fused rock-forming silicates the following procedure was employed: a layer of diopside was placed in the bottom of a crucible with a layer of plagioclase above it, diffusion was permitted at constant temp. (above the melting temp. of both layers) for a definite period, the charge was quenched and the compn. determined at various depths by measuring the n of the glass. From these expts. it would seem that the movement of large amts. of material through long distances by diffusion can not be credited when the rate at which the magma must cool is considered. On the other hand, diffusion through short distances is possible and such phenomena as the formation of reaction rims about foreign inclusions are to be attributed to diffusion, though for very wide rims (2 m.) a considerable period of time (100 yrs.) will be required. W. F. HUNT (*C. A.*)

22. Kaolin in Belgium. E. ASSELBERGHS. *Ann. Mines Belg.*, **21**, 1059–67(1920); *Rev. geol.*, **1**, 292–93(1920).—Previously known deposits are discussed briefly and a new occurrence is described in detail. The kaolin from Ardenne is shown by a series of analyses to contain but 40% of impurities, which can be removed by levigation, yielding a product capable of competing with those of Devonshire and of Cornwall; the latter in fact has to be sepd. from 75% of impurities. E. T. W. (*C. A.*)

See also No. 25.

Refractories and Furnaces

23. The function of insulation and its application to heat-treating furnaces. E. F. DAVIS. *Trans. Am. Soc. Steel Treating*, **1**, 33–42(1920).—The requirements of insulators from the viewpoint of efficiency are given. Heat loss from a horizontal surface is 22% greater than from a vertical surface.

W. A. MUDGE (*C. A.*)

24. Properties and preparation of ceramic insulators for spark plugs. I. Methods of measuring resistance of insulators at high temperatures. F. B. SILSBEE AND R. K. HONAMAN. *Nat. Advisory Comm. Aeronautics, Fifth Annual Rept.*, **1919**, 77–89(1921).—Measurements were made at 200°–900° with both a. c. and d. c. at voltages up to 2000. Resistance decreased rapidly with increase in temp. in porcelain, mica, fused SiO_2, and similar materials but there are no sudden changes. A convenient comparison figure is the temp. (T_e) at which the resistivity is 1 megohm per cc. This temp. for various substances is: fused SiO_2, 890°; best porcelain tested, 790°; typical mica plug, 720°; av. of 3 aviation porcelains, 650°; av. automobile porcelains, 490°. In the measurements with d. c., polarization effects disturbed the readings. The mechanism of conduction in this class of materials is exceed-

ingly complex and merits wide investigation. **II. Electrical resistance of various insulating materials at high temperatures.** R. K. HONAMAN AND E. L. FONSECA. *Ibid.*, 91–99.—To obtain reliable findings, tests were made at 550 v., 60 cycle, a. c. Polarization was thus avoided. Cond. increased about 2% per degree. The temp. (T_e), at which resistivity was 1 megohm per cc., varied from 870° for fused quartz to 280° for some kinds of glass. Many findings are recorded. Porcelains developed at the Bureau of Standards showed as high as 800°. Most spark-plug porcelains show about 500°. Any material with T_e less than 400° should be used only when the design of the plug is such that the insulator is very well cooled. **III. Preparation and composition of ceramic bodies for spark-plug insulators.** A. V. BLEININGER. *Ibid.*, 101–107.—Spark plugs in airplane engines are subjected to high temps., sudden heating and cooling and mechanical stresses. A suitable material, therefore, must remain a good insulator at the max. temp. reached, not be subject to permanent vol. changes, possess const. thermal expansion and be strong and tough. The best types developed at the Bureau of Standards are given. No. 152 contained: Georgia kaolin, 10; Florida kaolin, 10; N. Car. kaolin, 10; Del. kaolin, 10; Calcine No. 19, 40; Calcine No. 14, 20%. Calcine No. 19 contained: Kaolin, 70.2; Al_2O_3, 27.8; B_2O_3, 2.0%. Calcine No. 14 contained: Kaolin, 56.0; $MgCO_3$ (pptd.), 18.2; potter's flint, 25.8%. Another excellent porcelain was No. 194 containing: Beryl, 35.0; Georgia kaolin, 12.5; Florida kaolin, 12.5; N. Car. kaolin, 12.5; Del. kaolin, 12.5; potter's flint, 15.0%. C. H. KERR (*C. A.*)

25. An organism producing magnesia. M. GIGNOUX. *Compt. rend. somm. soc. géol. France*, Feb. 4, **1918**; *Rev. geol.*, **1**, 72(1920).—As bearing on the problem of the origin of dolomite, it is pointed out that there is a very common protozoan, *Trichosphaerium*, the skeleton of which is formed entirely of $MgCO_3$. E. T. W.(*C. A.*)

26. Behavior of clay pyroscopes and fireclay bricks in coal gas. L. BRADSHAW AND W. EMERY. *Gas World*, **74**, 503-504(1921).—From the Report of the Refractory Materials Research Comm. of the Institution of Gas Engineers. Seger cones, when heated in coal gas to temps. well above their ordinary softening points, remained erect. On examn., they were found to consist merely of a hollow shell with a quantity of slag discharged at the base, or of a semi-vitrified mass covered with an infusible skin. The outer shell was extremely refractory. It appeared to be due to the formation of a thin film of hard carbon in intimate contact with the surface of the cone. This effect was found to be due to the decompn. of CH_4 which forms a peculiarly hard and lustrous type of carbon (cf. Bone and Coward, *C. A.*, **2**, 3061). Fireclay brick heated under the same conditions assumed a similar surface deposition. The idea of a protective coating of hard carbon artificially produced on fireclay surfaces might possibly be utilized in gas works practice, as the refractoriness of the shell is very much higher than that of the untreated material. J. L. WILEY (*C. A.*)

27. The vapor pressures of SiO_2, Al_2O_3, CaO and MgO. OTTO RUFF AND PAUL SCHMIDT. *Z. anorg. allgem. Chem.*, **117**, 172(1921).—This report

presents the results secured using the app. and method described in earlier papers (*Z. anorg. Chem.*, **82,** 373(1913); **106,** 76(1919)).—In certain of the expts. Ar. was used as a furnace atm. and the graphite container was glazed with a mixt. of 3 parts of vanadium carbide and one part of vanadium oxide. The boiling points observed are as follows: Al_2O_3, 2210°; SiO_2, 2230°; CaO, about 2850° and MgO, about 2800°. For the first two oxides linear logarithmic v. p. curves were obtained. It is planned to repeat the work using a tungsten container and an atm. of Ar. E. W. T.

28. Symposium on gas firing. Dr. E. W. SMITH AND OTHERS. *Trans. Ceram. Soc.*, **20,** 20–38(1920).—The cost of mfg. producer gas as compared with coal gas and blue water gas, is in the relative proportion of 3, 4 and 5. Almost any combustible fuel can be employed, providing it is of reasonably constant quality. In most industrial operations, where the gas has not to be distributed, and where the application is sufficiently large to put a producer in the setting of the particular furnace, the internal producer is the cheapest form to run. With an internal producer, it is possible to obtain a hot gas, with an effective c. v. of between 155–160 B. t. u. per cubic foot. Up to 20 percent of heat can be saved by using hot gas in preference to cold. It will pay to sacrifice a little efficiency in gasification, if the labor costs can be reduced considerably. By the adoption of a step grate, clinker troubles will be minimized, but loss of carbon in the ash occurs. By complete gasification of coal it is possible to obtain per ton of fuel about 50,000 ft. of gas of a thermal value of about 360 B. t. u. with inerts of about 6 percent, including the N and the CO_2. The plant is as easy to manipulate as a blue water gas plant; and will use either coke or coal. It will probably never be possible to make gas by means of complete gasification as cheaply as producer gas, and since all industrial operations of any magnitude only require a gas of producer gas quality, producer gas will continue for some time to be the gas that is mainly used. J. DUNNACHIE.—Gas-firing will save 50% of the fuel that is consumed in a direct-fired kiln, apart from which there is considerable saving also in labor. Gas-firing makes it possible to centralize the work, and obviates the necessity of distributing fuel to, and ashes from, kilns scattered about. The wear and tear on a gas-fired kiln is also considerably less than in the case of a coal-fired one. There is a danger of gas kilns being too elaborate and complicated in the way of flues and dampers. S. T. WILSON.—For goods that require an oxidizing fire and equal temp. gas-firing can only be safely adopted where the gases are so intimately mixed as to produce surface combustion, and if they are burnt in the combustion chamber then they will lose their heat very quickly as they travel across the oven. For this reason the oven must have a very small cross-sectional area, too small for a man to work in but large enough for a tunnel oven. Where the goods to be fired are not injured by contact with the combustible gases or air, then gas can be safely used with recuperation because streams of gas and air can be placed at such an angle that combustion will take place all along its path across the oven and so one end of the flame can be made as hot as the other and consequently

an even temp. can be produced. Large chamber ovens can be used in this case. Col. C. W. Thomas.—The gaseous-fired kiln or furnace is economical because of recuperation or regeneration. It is not so much in the change from solid to gaseous fuel that economy is realized as in the method by which the regenerative system of firing is carried out. For some years Col. T. has had in use an ordinary 28-chamber continuous kiln, coal-fired, burning ordinary firebrick sizes up to 3 and 4 inches thick, to a temp. of cone 9 down; the fuel used has been the ordinary fuel of the S. Staffordshire district, in the form of small nuts. The waste gases have been taken to the chimney at a temp. of from 150° to 200°C, and the consumption of fuel has varied between 2.2 and 1.8 cwts. to the ton of fired material. No figures have been reported for gas-firing which have been lower than those. From the point of view of fuel economy every kiln in which the waste gases are allowed to go to the chimney at anything over 150° or 200°C is sheer waste. Everybody, sooner or later, will have to come, if not to gaseous firing, to recuperative or regenerative firing. H. F. S.

PATENTS

29. Basic refractory material. Harry P. Bassett. U. S. 1,390,328, Sept. 13, 1921. The herein described basic refractory material comprises double burned dolomite, an oxide of a metal of the iron group, an alkali metal compd. and a silicon compd.

30. Acid-proof refractory composition. Harry P. Bassett. U. S. 1,390,-327, Sept. 13, 1921. The herein described acid proof refractory composition comprising silica, a metal comprised within the iron and aluminum groups, an alkali metal coumpound and a silicate binder.

31. Apparatus for heating by combustion without flame. Maurice Mathy. Belgium. U. S. 1,388,355, Aug. 23, 1921. A furnace having one or more of its heating walls in the form of boxes containing a mass of fragmentary porous, refractory material in the heart of which flameless combustion of a gaseous mixt. takes place.

32. Kiln. Harford P. Jenks. U. S. 1,386,116, Aug. 2, 1921. A kiln provided with a perforated floor, a checker-work heat-reservoir located below the floor and adapted to receive the hot gases passing through the perforations of the floor, a down-take located at the edge portion of the reservoir and forming an outlet therefor, and a flue connected with the lower portion of the down-take and having an imperforate upper wall extending along the lower portion of the heat-reservoir, and in contact, throughout its length, with the bottom wall of the reservoir.

33. Tunnel-kiln with sectional combustion-chambers. Philip D'H. Dressler. U. S. 1,384,435, July 12, 1921. In a continuous tunnel kiln, the combination with a kiln chamber having an elongated hot zone, of a plurality of combustion chambers arranged in an end series extending longitudinally of the hot zone and having air and gas inlets at one end and an outlet for products of combustion at the other end and of such proportions that the distance between the inlet and outlet of each chamber is several times the max. transverse dimension of the chamber.

34. Parallel-current calcining-kiln. HARRY E. BROOKBY. U. S. 1,390,335, Sept. 13, 1921. A common direction, parallel current, calcining kiln having a rotary shell, a combustion chamber projecting into the shell, and means for introducing the charge into the shell and passing it over a portion of the surface of the combustion chamber for raising the temp. of the charge and lowering the temp. of the gases of combustion before the two mingle in the shell. C. M. SAEGER, JR.

Whiteware and Porcelain

35. Note on the formation of blow-holes in earthenware glazes. J. BARLOT. AND JH. MARTINET. Univ. of Besançon. *Chimie & industrie*, **5**, 651–52(1921). —The most frequent defects found in the enamel of white panels were due to various impurities (Fe and Cu oxides, dirt from the ovens, etc.) or to excessively large grains in the layer immediately under the enamel. These grains often consist of $CaCO_3$, which causes shallow and irregular holes in the surface of the enamel owing to the liberation of CO_2. Another defect consisted of small round, funnel-shaped cavities, in the bottom of which could nearly always be found a small black particle. Microchem. anal. showed the presence of S by transformation into $CaSO_4$, and also of Fe, which results from the decompn. of FeS_2 into FeS and S. A. P.-C. (*C. A.*)

36. High fire porcelain glazes. H. H. SORTWELL. *Bur. Standards, Tech. Paper*, No. **196**; *This Jour.*, **4**, 718–30(1921). H. F. S.

37. Unestimated losses in pottery manufacture. *Trans. Ceram. Soc.*, **19**, 14–25(1920).—**Works blindness.** J. W. MELLOR.—Works blindness is a kind of disease attended by the blunting of the observational powers due to constant association with a particular works or process.

Recovery of gold residues. C. D. GRIMWADE.—The recovery of the gold is achieved by burning the rags, brushes, and other paraphernalia used by decorators, either in applying gold to ware or in cleaning up and in fusing the ash to a clear glass. A mixt. which has proved very suitable is: Ash 12 oz., borax glass 10 oz., potassium nitrate (nitre) 2 oz. No benefit could be observed from covering the mixt. with a layer of salt.

Wad clay. BERNARD MOORE.—The diff. in the amount of wad clay used between using a wad 0.3 inch and one 0.7 inch, is that the one is more than 5 times the wt. of the other. Within reasonable limits, the less wad clay used, the less dirty ware will the oven yield. In the Research Laboratory at Stoke, square wads are cut the right size to put on the saggars. These are of more uniform texture than squeezed wads. H. F. S.

38. Some new appliances in potting. A. S. W. ODELBERG. *Trans. Ceram. Soc.*, **19**, 42–49(1920).—**Electric carrier.** By means of an electrically operated overhead monorail conveyor, saggars filled with fired ware "wander" quite independently from the oven to the warehouse where they are emptied while in movement by the sorter, without removing of the saggars from the carrier. The saggars when empty return to the placing room near the oven, where they are taken from the carriers at the most convenient spot. A similar

arrangement is used for emptying the glost kiln and taking the goods from the glost warehouse through the other warehouses to the packing shed. The system requires about 50% of the labor formerly employed.

Modification of Schöne's apparatus. A simple app. in which only one can is used and one sepn. made.

Jolleying square dishes. A perfectly rigid jolley is used with all the necessary movement in the jigger head. This is effected by means of a guide plate fixed on the bench. In this guide plate is a groove in which a stud projecting from the jigger head runs dead true. The groove is of very peculiar shape, and has to be determined empirically by reversing the process. The shape wanted is first modeled, and then placed on the jigger head, fitting exactly to the profile of the rigid jolley. Instead of the stud in this case a pencil or needle is fixed to the jigger head, and made to trace the path of the groove on a plaster bat fixed on the bench, simply by turning the jiggerhead so that the mould runs true to the profile. The cast iron guide is then modeled from the plaster bat. It has been found that a man with this machine will make as many articles as with the ordinary oval jigger and jolley, including both flat and hollow ware.

Plate-making machinery. This is constructed according to the latest English pattern with cast iron frames so as to get as much rigidity as possible. The jolley is provided with loose profiles adjustable in the usual manner by means of a nut. The batting machine has a separate frame so as to prevent any jarring in the plate-making machine. It is semi-automatic; the moment the profile is pressed down the jigger head begins to revolve.

Insulators. These are also made by a jigger and jolley instead of by a "monkey." By lengthening the jolley arm and fixing it in an inclined position it is possible to make the profile lift vertically and deliver easily. When the insulators are turned and thoroughly dry, a groove must be made at the top for the wire. The work is accomplished by means of a felt wheel acting like a circular saw and running at 4000 rev. per min. It is partially enclosed in a casing connected with a fan. The groove of the insulator is made in a few seconds, and considerable labor is saved.

Cup and mug handles. These are formed in steel dies heated by an elec. "resistance" fixed inside. The top die is kept somewhat hotter than the bottom one, which facilitates delivery. In this process no oil is needed to make the clay deliver readily from the steel die, and after cooling, the handles are ready to be fixed to the cups.

Heating channels from the ovens. A brick flue (about half a meter square) was built from two ovens. The outlet from the ovens was just over the arch. An extra damper was placed at the top of the cooling cone, and an extra flue provided with a damper was made to connect with the outside air. A motor driven Blackman's fan (70 cm. diam.) was used. After the oven had cooled a little, both the top cone damper and the main flue (bottom) damper were closed, and the motor started. In order that the air should not be so hot as to injure the fan, the shaft or the bearings, the damper of the cold-air flue was

opened in order to bring about a partial cooling. In this way the fan maintained for several days a steady current of air at about 300°C flowing through a drying mangle, and this was quite an efficient subs. for steam. The fan consumed daily 30 to 40 units corresponding to 40 kg. of coal. The boilers consumed 4500 kg. coal, 15% of which amounts to 670 kg. coal, which is the quantity of coal equiv. to the steam formerly consumed in the mangle. Thus at the expense of 40 kg. coal, heat corresponding to 670 kg. coal was obtained. H. F. S.

39. Whiteware glaze defects and their prevention. MAX SCHMIDT. *Keram. Rundschau*, **29**, 341–42, 365–66, 389–90, 412–13, 435–36(1921).—In the prepn. of frits, boric acid is partly volatilized whereby the fluxing effect of this ingredient is partly lost. If S is present in the furnace gases, it combines with the alkalies of the glaze forming a scum known as "gall." During the wet grinding of the glaze these sulphates go into soln. The introduction of kaolin into the frit during the melting process is advizable since this keeps the mass porous, thus promoting oxidation. In the wet grinding of glazes there is a tendency for the glaze to settle and to set similar to cement. This is due to the formation of sodium silicate which causes the cementing. By adding vinegar, dil. HCl, or NH_4 salts, this trouble may be overcome. When this add. is made there is a big increase in vol. due to the formation of silicic acid. To prevent trouble due to this source it is advizable to first add $^1/_3$ of the necessary deflocculent when charging the mill and the other $^2/_3$ after the charge has been ground. The flaking of dry glazes from pottery is due to too fine grinding and too plastic clays. This trouble may be overcome by subs. calcined kaolin for some of the raw clay. It is also advizable to soak the piece with water in order to remove entrapped air from the bisque pottery. The presence of sol. sulphates in clays often causes the dry glaze to scale from the pottery especially along edges. This may be overcome by adding Ba salts to the clay. In firing glazes the soln. of the pottery body by the glazes is an important factor. This often causes the glaze to have a matt appearance. To overcome this the introduction of Al_2O_3 into the glaze is recommended and also more rapid firing during the glost burn. Sulphur in the kiln gases also causes dry spots on glazes and the saggars should therefore be well glazed. Seger's rule which states that crazing may be reduced by subs. a metallic oxide of lower equivalence for one of higher equivalence does not hold true for borax free glazes. Crazing may be reduced by reducing the alkali content, subs. K_2O for Na_2O, or by the subs. of MgO or ZnO for PbO. Too much MgO causes the glaze to become too viscous and too much ZnO causes the glaze to become cryst. H. G. SCHURECHT

40. The perfection of electrical porcelain. THOMSON-HOUSTON, *Le Génie Civil*, **15** (1921); *Tonind. Ztg.*, **45**, 1041(1921).—A process for making elec. porcelain covered by Fr. pat. 506,861, Aug. 31 is described. This process is based upon the fact that the elec. and mechan. props. of porcelains are improved by subs. certain refractory oxides for some of the SiO_2. Not all of the SiO_2 is replaced by the refractory oxides. For ex. a zirkite

body is composed of the following constituents: 81% $ZrSiO_3$, 14% SiO_2 and the remainder TiO_2, Al_2O_3 and Fe_2O_3. TiO_2 and ZrO_2 are especially recommended as subs. for SiO_2. By heating the common porcelain to 800°C and plunging same in water it becomes very friable while the special body is barely affected by this treatment. The tens. strength of the new body is 7400 instead of 4300. The elec. properties of the special porcelain are the same as those of the common porcelain at ordinary temps. At 280°C the special porcelains have a resistance of 2.43 megohms whereas the common elec. porcelains have a resistance of only 0.8 megohm. The special porcelains also have other valuable props. For ex. they are less porous than ordinary porcelains and contain constituents which are more stable than SiO_2 in heating and cooling. H. G. SCHURECHT

41. The use of the Ulbricht sphere in the measurement of reflection and transmission factors. *Bur. Standards, Sci. Paper,* No. **415.** ENOCH KARRER.—A brief historical survey is given of the methods and instruments used in measuring the reflection factor of surfaces. One of the new ways consists in a combination of the sphere with the Martens polarization photometer. The photometer enables a direct comparison to be made between the brightness of the sphere wall and the brightness of the test surface which closes an aperture in the sphere. The sphere wall is illuminated by directing a narrow beam of light through an aperture that is closed by the sample. The sample is illuminated by the sphere wall, but is screened from the direct light from the illuminated spot. The ratio of brightness which is obtained by means of the Martens photometer is exactly the reflection factor of the test surface. Thus the r. f. is determined by one observation without further calcn. and without the use of a standard reflecting surface. This method may be modified so that the transmission factor may likewise be detd. absolutely. A simple and inexpensive reflectometer is also described that may be of service for certain commercial purposes where an accuracy of 10 to 15% is allowable. Some data are given to show that the r. f. of magnesium carbonate in blocks as frequently used in photometry is as high as 98.7%, corroborating some recent detns. by others. The value for magnesium carbonate has until recently been assumed to be 88%. All blocks of magnesium carbonate as ordinarily purchasable have not as high a r. f. They may vary by several percent. H. F. S.

See also No. 24.

Art and Design

42. Art in the pottery industry. (Symposium on Art.) G. M. FORSYTH. *Trans. Ceram. Soc.,* **20,** 2–7(1920).—The word "Art" is used to signify work evincing practical skill in the creation of beauty. "The application of living healthy artistic ideals to pottery manuf. means the soundest economy, and is essentially a business proposition, for the designer or the artist has the last word in production, and the effect of his work is first to sell the goods. It means that good workmanship replaces bad, and that common-

sense beauty replaces extravagant ugliness wherever it exists in any grade of ware for any market in the world. There is today an incessant and increasing demand for well-decorated pottery of a purely utilitarian type." "We deliberately degrade our craft, and then moan about it, saying that we have no skilled men, or we take refuge in saying that 'This is what the public wants,' pure humbug and subterfuge." "It (Art) is the bride of the ages, elusive, forever beautiful, and gifted with eternal youth." H. F. S.

43. A plea for toleration in Art. (Symposium on Art). J. W. MELLOR. *Trans. Ceram. Soc.*, **20,** 11–19(1920).—

> Myself when young did eagerly frequent
> Doctor and saint, and heard great argument
> About it and about; but evermore
> Came out by the same door, where in I went.
> —*Omar Khayyam.*

"There are fashions in Art. Custom will make us satisfied with one fashion until a new one appears. A dream of a hat one season may, the following season, be an ugly nightmare. In countries where men's faces are bare, men with beards are regarded as horrors. The practices of certain nations tattooing the body, painting the skin, putting skewers through the nose or lips, elongating the skull, or distorting the feet, are not regarded as deformities, but are presumably intended to enhance the beauty of the human form. The Hottentots can perceive more loveliness in their—to us—ugly Venus than in the—to us—beautiful Grecian Venus of Melos. Thus a design may be regarded as beautiful in one country, and hideous in another. There are designs which to us are beautiful and artistic which are blasphemous and ugly to another nation. The canons of Art are very different with different peoples; and perhaps to a less extent with the same peoples trained in different schools of Art. Certain charms in a woman may attract one man and not another; one man marries a drooping eyelid, another a dimpled chin, another a supple waist, and still another a bewitching ankle. The standard of Art or beauty varies with the individual's temperament; it varies with a nation's customs, traditions and habits; and it varies with time, and changes with the prevailing fashion." "When a man claims that 'the public taste wants educating,' I understand him to mean that the public taste differs from his own, and that he would like some missionary work done to try and get their standards in harmony with his own. I deny the right of any man to say that an object beautiful to me is ugly in the abstract, though it may be ugly enough to him. In Art and Politics I am a strong Individualist—*quot homines, tot sententiae,* so many men, so many minds." "Our descriptions of colour are very shocking. A man cannot be frightened as 'white as a ghost,' but his bloodless skin may appear dirty yellow. We say that a girl has sky-blue eyes, when they are really the colour of slate; that she has 'ruby lips' or 'cherry lips,' when they are really the colour of Accrington facing bricks; and that her skin is 'white like the hawthorn buds that open in the month of May' when the real colour is not unlike that of a Swede turnip." H. F. S.

44. Pottery design from the manufacturer's point of view. (Symposium on Art). H. J. PLANT. *Trans. Ceram. Soc.*, **20,** 8–10(1920).—The potter is no powerful enough to sway the nation's fancy. "The most successful designer is he who keeps well in touch, and is ever playing up to the public, following every fickle fancy, and working every craze to his utmost capacity. This requires breadth of conception. The man with fixed ideas is incapable of producing patterns to suit all markets, not that he must be willing to produce designs having no artistic merit, but that his designs must be beautiful in a way that will appeal to the people for whom they are made." "Certain designs produced by a capable man were approved at the Ceramic Society's adjudication last year, but knowing from experience the public taste, another range of samples was made, and both lots put on the market together, with very discouraging results to the adjudicators' approved works. The patterns done to suit the market had a far greater sale than the conventional art designs. The prices of both lots were very similar. The kinds of work very much appreciated throughout the country were borders with naturalistic rose sprays tastily displayed underneath, also roses with narrow brown borders underneath, festoons, scattered flowers, flowers connected by choice bits of ornament, and various other styles suitably colored to meet the present day fancy." H. F. S.

Heavy Clay Products

PATENTS

45. Black tile. TATSUZÔ SHIMOSE. Japan 36,725, July 6, 1920. A mixt. of 60% graphite and 40% fire-proof clay is made to a paste with H_2O, painted on common tile and fired in a kiln to produce fire-proof black tile. (*C. A.*)

46. Material for and process of forming brick, tile, and the like. LLEWELLYN JONES AND CHARLES WESTLAKE, JR. U. S. 1,390,038, Sept. 6, 1921. A material for dry pressing in the formation of brick, tile and the like, containing silica from 65 to 75%, lime from 20 to 30% magnesia from $1^1/_2$ to $3^1/_2$ and sulphur from $1^1/_2$ to $3^1/_2$%.

47. A machine for producing hollow bricks. BROR OSCAR WALTER HESSELMAN AND OSKAR GOTTFRID MEINHARD. Stockholm, Sweden. U. S. 1,386,404, Aug. 2, 1921. In a machine for molding blocks, the combination of a mold, a support, means for moving the mold into operative position at one side of the support and into inoperative position away from the support, means for applying pressure to the material in the mold and means for automatically relieving the pressure when the mold reaches its inoperative position.

48. Brick-kiln construction. JAMES T. POKORNY. U. S. 1,386,530, Aug. 2, 1921. A brick mfg. plant, a fire chamber, drying and firing chambers arranged in superimposed relation above the fire chamber, the floor of the drying chamber having opening therein to admit the heated air circulating about the exterior of the fire chamber, and fuel conducting pipes connecting the firing room with the fire chamber.

49. Apparatus for the manufacture of bricks or building blocks. EDMOND LECHAT. Nantes, France. U. S. 1,383,131, June 28, 1921. A feeding app. for brick- or building-block presses, comprising in combination upper troughs containing the concrete used to form the main body or core of the brick or block, lower troughs containing the concrete used to form a facing upon one or more sides of the brick or block, endless aprons constituting the movable bottom of the distributing troughs, each trough being provided with adjustable shutters, spouts vertically moved extending through an opening into the mold of the press, a series of feeding chutes leading the first of the qualities of concrete into the spouts and another series of feeding chutes leading the second of the qualities of concrete around the spouts.

50. Building brick. JAMES P. WILLIAMS. U. S. 1,385,961, July 26, 1921. A building brick comprising side load-sustaining members, hollow throughout their length to provide longitudinal air-cells; a central load-sustaining member of approx. the same dimensions as the side members and also provided with a longitudinally-extending air-cell; there being at least three of such air-cells in the brick; and solid webs connecting the central load-sustaining member with each of the side members and extending in horizontal planes from the central member approx. midway of its top and bottom portions; the upper and lower faces of each of the side members being in the same plane; the side members being in balanced relation to the central member; the central member presenting two oppositely-disposed hand-holds, whereby the brick is rendered reversible and adapted to be gripped at either side; and there being between the central member a mortar joint-breaking channel having right angularly formed walls.

51. Brick or building block. JEAN E. KEIFER. Lausanne, Switzerland, U. S. 1,382,652, June 28, 1921. Hollow half bricks or building blocks having sides of equal length and so shaped that when the equal sides are placed together they form a brick or block having at least one face or side shaped as an S with equal limbs.

52. Process of manufacturing and handling brick. GRAFTON E. LUCE. U. S. 1,384,393, July 12, 1921. The process of handling articles during their continuous travel, which consists in moving a carrier against their line of travel, engaging the articles and then retracting the carrier at a speed equal to or greater than the travel of the articles.

53. Revolving crane for brick handling. GRAFTON E. LUCE. U. S. 1,384,768, July 19, 1921. App. of the kind described comprising a rotatably mounted table, a carriage mounted for forward and backward movement thereon, a boom carried by the carriage, a frame suspended from the boom, and links connecting the frame and the carriage to maintain the same parallel to each other.

54. Fire-brick trimming or beveling machine. FRANK WIERZBOWSKI. U. S. 1,383,686, July 5, 1921. In a brick-trimming machine of the class described, a carriage adapted to have a grinding or dressing stone clamped therein, means to horizontally reciprocate the carriage, a brick-supporting

pallet, means to elevate the pallet to engage the upper surface of the brick thereon with the stone carried by the carriage, means to adjust the pallet at an angle to the horizontal whereby beveling of the brick may be had, the last named means including a vertically movable standard having a spider fastened upon the upper end thereof, and set screws threaded upward through the spider in supporting engagement with the under surface of the pallet.

C. M. SAEGER, JR.

Glass

55. The relation between the density and chemical composition of glasses. SA. *Keram. Rundschau*, **29**, 366–67, 390–91(1921).—The d. of glasses may be calc. from their chem. anal. and d. factors as follows:

$$\frac{a}{A} - \frac{b}{B} - \frac{c}{C} - \ldots\ldots\ldots - \frac{n}{N} = \frac{S}{X}$$

a, b, c ..... n are the percents of these constituents in glass, A, B, C ..... N are the factors for the different oxides and X is the d. of the glass. The d. factors are not the same as the d. of the uncombined oxides, this being especially true with Al_2O_3 and Sb_2O_3. The ds. of the same glass may vary 2% according to the method of manuf. In CaO–MgO–SiO_2 glasses the d. factor for MgO is higher while, in Na_2O–MgO–SiO_2 glasses it is lower than the d. of the pure oxide. The true ds. and the d. factors for different oxides in glass are given below:

			Density Factor in Glass		
Oxide	Density		Winkelmann	Tillotson	Baillie
SiO_2	2.22	Deville 1855	2.3	2.3	2.24
Al_2O_3	3.85	Rammelsberg	4.1	2.75	2.75
Sb_2O_3	6.69	...	...	...	3.00
B_2O_3	1.79	Clarke	1.9	2.24	2.90
As_2O_3	3.74	...	4.1	(4.1)	3.33
ZnO	5.65	Schröder	5.9	5.9	5.94
BaO	5.00	Clarke	7.0	7.0	7.20
CaO	3.30	Moissan	3.3	4.1	4.30
MgO	3.60	Clarke & Moissan	3.8	4.0	3.25
PbO	9.30	Clarke	9.6	9.6	10.30
K_2O	2.66	...	2.8	(2.8)	3.20
Na_2O	2.55	...	2.6	2.8	3.20

H. G. SCHURECHT

56. Progress in manufacturing radio-protective glasses. W. W. COBLENTZ. *Optician*, **58**, 265(1920); *J. Soc. Glass Tech.*, **4**, 27.

H. G. (*C. A.*)

57. Synthetic helium and neon. A. LO SURDO. *Atti accad. Lincei* [v], **30**, i, 85–88(1921).—L. finds that Ne, He, and H are able to pass through *hot glass*, the H in far greater quantity than the other two gases. The passage is dependent on the temp., nature, and thickness of the glass. These results may furnish an explanation for the origin of so-called synthetic He and Ne, which may be derived from the atm. J. C. S. (*C. A.*)

58. Electric load conditions in the glass industry. C. W. FICK. *Gen. Elec. Rev.*, **24**, 539–42(1921); illus.—Includes a brief account of modern plate-glass manuf. C. G. F. (*C. A.*)

59. Nomenclature of glass. C. J. PEDDLE. *J. Soc. Glass Tech.*, **17,** 3–15(1921).—*A plea for standardization* international if possible, of glass nomenclature. At present there is much confusion because of overlapping of trade names and technical terminology. A *set of rules is suggested* for a standard nomenclature which specifies the constituents. In the case of optical glass it is suggested that the main classes be subdivided according to the refractive index for the D lines instead of according to d.

W. C. TAYLOR

60. Comparison of the alkali-lime-silica and the alkali-lead oxide-silica glasses. Part X of "The Development of Various Types of Glass." C. J. PEDDLE. *J. Soc. Glass Tech.*, **17,** 72–106(1921).—Several series of glasses were prepared and studied containing (1) 20 or 40 mol. of Na_2O or K_2O and 5 to 40 mol. of CaO or PbO or a mixt. of the two, to 100 mol. of SiO_2, and (2) 10 to 25 percent of Na_2O or K_2O and 5 to 20 percent of CaO or 5 to 30 percent of PbO and 60 to 70 percent of SiO_2. The *density and total dispersion* are higher for lead than for the corresponding lime glasses of corresponding mol. or percentage compns. and the *refractive index* is higher in lead glasses of the same mol. compn., but not as high as lime glasses of the same percentage compn. except when the SiO_2 content is under 60 percent and at the same time the alkali content greater than 20 percent. Also the lead glasses show a relatively greater dispersion toward the blue end as compared with the red end than corresponding lime glasses. Lime glasses are more prone to *devitrification* than lead glasses, particularly if they contain soda, but their *soly.* is less weight for weight and also when compared molecularly unless the alkali content is under 15 percent. For lime and particularly for lead glasses with an alkali content less than 20 percent, glasses containing equal weights of Na_2O and K_2O are less sol. than corresponding glasses containing only one alkali. The *weathering* results are very similar to those for soly.

W. C. TAYLOR

61. Influence of aluminum on the working properties of glass. VIOLET DIMBLEBY, F. W. HODKIN AND W. E. S. TURNER. *J. Soc. Glass Tech.*, **17,** 107–115(1921).—Two series of glasses were prepared, (1) $6SiO_2$, xNa_2O, yAl_2O_3 where $x+y=2$, and (2) $6SiO_2$, $1.1Na_2O$, $xCaO$, yAl_2O_3 where $x+y=0.9$. With temp. of 1400–1425°C the authors were unable to melt and plane a glass containing above 13 percent Al_2O_3 in the first series and 7.5 percent Al_2O_3 in the second; yet in the latter series small amts. of Al_2O_3 rendered the soda-lime glass more readily fusible. In the first series, increasing the alumina rapidly increases the *viscosity and toughness* and its tendency to acquire a hard skin on marvering. But alumina was found very favorable to easy *manipulation in lamp working* and also of value in preventing *devitrification*. The *thermal conductivity* seemed to decrease as the alumina content increased.

W. C. TAYLOR

62. Effect of aluminum on the annealing temperature of glass. S. ENGLISH AND W. E. S. TURNER. *J. Soc. Glass Tech.*, **17,** 115–18(1921).—The annealing temp. was determined by the optical method for the two

series of glasses described in the preceding abstract, with the conclusion that *when replacing magnesium or calcium* mol. for mol. and also g. for g., aluminum reduces the annealing temp. in most cases. G. S. FULCHER

63. Some optical properties of the sodium-aluminium tri-silicate glasses. J. R. CLARKE AND W. E. S. TURNER. *J. Soc. Glass Tech.*, **17,** 119–20(1921).—Data are given for the *refractive index and dispersion* of four glasses with the compn. $6SiO_2$, xNa_2O, yAl_2O_3 where $x+y=2$ and the alumina was varied up to 9 percent. The index increases with the d. but not so fast, whereas the dispersion increases faster. G. S. FULCHER

64. Effect of sodium oxide on the thermal expansion of sodium silicate glasses. S. ENGLISH AND W. E. S. TURNER. *J. Soc. Glass Tech.*, **17,** 121–23. (1921).—The *expansion* coeff. for seven sodium silicate glasses with silica content of from 67 to 83 per cent were detd. The results correspond to the equation: $\alpha \times 10^8 = 5.0 + 4.20N - .0002N^3$ where N is the percent Na_2O. Taking the factor for 1 percent silica as 0.05×10^{-6}, the factor for Na_2O is 4.25×10^{-6}. For cubical expansion the corresponding factors come out 0.15 and 12.75 instead of 0.8 and 10.0 as given by Schott. The value for Na_2O agrees well with that previously obtained from sodium-calcium glasses, 12.96. G. S. FULCHER

PATENTS

65. Drawing and painting glass. ANSON K. CROSS. U. S. 1,387,439, Aug. 9, 1921. A painting corrector comprising a spirit level and means for producing side by side two blurred images, one of the subject and the other of its representation, and a frame in which the elements are so mounted that the spirit level indicates the correct leveling of both the frame and the image-producing means.

66. Automobile-headlight glass. WILLIAM G. SCHNEIDER. U. S. 1,391,511, Sept. 20, 1921. A headlight glass of the character described, comprising a glass plate having series of undulations over the entire surface of one side thereof, and having outwardly rounded, raised portions forming a spotted arrangement over the entire surface of the opposite side, the cross sectional width of the undulations being greater than the cross sectional width of the rounded raised portions, and the border of the glass being of less translucent character than the central portion of the glass.

67. Lens-cutting machine. WALTER W. SLADE. U. S. 1,388,774, Aug. 23, 1921. A lens-cutting machine of the kind described, comprising a swinging support for the cutter, adapted to be held under spring tension toward the work to be operated on, and a lever operable to move the work holder out of operative position.

68. Abrasive for grinding and smoothing glass. WILLIAM L. KANN. U. S. 1,387,649, Aug. 16, 1921. The method of grinding, smoothing and finishing glass preparatory to polishing, comprising supplying to the glass a natural cryst. abrasive of such character that as it is crushed and broken the

smaller grains and particles thereby produced are of distinct cryst. form, and continuously collecting and supplying to the glass such abrasive during the grinding, smoothing and finishing operations.

69. Glass-discharging mechanism. EDWARD S. HUTTON. U. S. 1,391,957, Sept. 27, 1921. Discharge means for a glass tank, including a discharge member adapted to extend through the wall of the glass tank and beyond the inner and outer surfaces thereof and having a glass conduit leading from the bottom of the inner end of the member upward and thence horizontally to the outer end of the member and thence upward to a point slightly above the normal level of the glass in the tank and thence downward to the discharge outlet, and an air conduit leading from the outer end of the member horizontally to the inner portion of the glass conduit and means for introducing air under pressure in the air conduit.

70. Sheet-glass-drawing machine. CLARENCE A. RHONEMUS. U. S. 1,391,405, Sept. 20, 1921. In a sheet-glass drawing mechanism, the combination of a pot containing a mass of molten glass and having oppositely-disposed discharge portions below the glass level, and vertically moving, longitudinally-slotted tubes having transverse openings therein, with transverse glass scoring mechanism entering the opening, and logitudinal glass scoring devices.

71. Sheet-glass-drawing apparatus. CLARENCE A. RHONEMUS. U. S. 1,391,406, Sept. 20, 1921. In a sheet-drawing app., a receptacle for molten glass from which the sheet is drawn, a cooler for the sheet adjacent the drawing point, gaseous heating means above the molten glass for heating the surface glass, and a shield between the heating means and the glass, transmitting the heat downward therethrough, but preventing direct contact of the hot glass with the cooler.

72. Method of making bifocal lenses. HENRY A. SCHEUERLE. U. S. 1,383,863, July 5, 1921. The method of making bifocal lenses which consists in rotating the blank to be abraded, with the minor area at the axial region thereof and the major area at the distal region thereof, while rotating abrading means contiguous to the major area in an annulus encircling the axis of rotation of the blank but eccentric to that axis; and preventing any change in the direction of the respective axes during the abrading operation; and thereby preventing abrasion of the axial, minor region of the blank while circularly abrading an annular, major region of the blank concentric with the axis of rotation of the blank but eccentric to the axis of rotation of the abrading means.

73. Frosted glass and process for making same. CHARLES F. LORENZ. U. S. 1,386,880, Aug. 9, 1921. The process of finishing a glass surface which consists in sand-blasting the glass surface and afterward rubbing the surface with an abrasive.

74. Apparatus for drawing sheet-glass. THOMAS S. OWENS. U. S. 1,386,-724, Aug. 9, 1921. In a continuous sheet-glass drawing app., two sheet drawing units disposed in opposite relation at opposite sides of a sheet being drawn, each of the units comprising shafts transversely spaced longitudinally

of the sheet, sprocket wheels carried by each shaft, a pair of sprocket chains connecting the wheels and spaced longitudinally of the shafts, and sheet engaging bars connecting the chains and spaced longitudinally thereof to provide a considerable space between the points of engagement of a sheet by the bars, the bars of one unit coöperating with those of the other unit to grip and impart drawing movements to the engaged sheet, the bars of the separate units also coöperating to score and weaken the engaged sheet at the points of gripping of the same.

75. Means and method for producing charges of molten glass. CLYDE R. LOTT. U. S. 1,382,993, June 28, 1921. The method of feeding molten glass, which consists in intermittently delivering from a tank to a container exterior thereto, predetermined quantities of molten glass, causing the same to be intermittently discharged downward from the container through an outlet orifice and subjecting the discharged glass to the action of a mech. shearing means spaced below the oriface whereby mold charges are formed.

76. Production of bores in glass. JOSEPH KENT. Maldon, England. U. S. 1,382,650, June 28, 1921. The method of manuf. glass tubing, which consists in incorporating with a mass of glass a sealed length of glass tubing, and thereafter drawing out the piece thus constituted until it is reduced to the required cross sectional dimensions.

77. Apparatus for sawing glass. WILLIAM TAYLOR. England. U. S. 1,385,731, July 26, 1921. App. for sawing glass, which comprises in combination a saw, a work holder for supporting the glass to be sawed, means by which one of the members tends to move to cause a relative approaching movement between the glass and the saw with a force sufficient to effect the approaching movement at the desired rate when the saw is in proper working condition but not sufficient to damage the saw or the glass when the saw is blunt, and means for limiting such approaching movement to a predetermined rate slightly less than that which would normally overload the saw.

78. Machine for making glass bottles. CHARLES F. COX. U. S. 1,385,428, July 26, 1921. In a bottle-making machine, an inverted mold for receiving the molten glass, shears above the mold for removing the excess glass, a downwardly movable plunger provided with a bottom finishing head, means for operating the shears, and means controlled by the shear operating means for both operating the plunger and rotating the neck-finishing head.

79. Mechanism for shifting plate-glass and grinding tables. FRANK E. TROUTMAN. U. S. 1,385,852, July 26, 1921. In app. for shifting plate-glass grinding tables, the combination of a suitable track, a grinding table, wheels on the table adapted to engage the track, means for disengaging the wheels from the track, a high-power elec. motor, a shaft driven thereby at relatively high speed, connections between the shaft and the table for rotating the same, a low power elec. motor, a shaft driven thereby at relatively low speed, and a magnetic clutch between the first-named shaft and the last-named shaft, the clutch being energized when the low power motor is started, whereby, when the low-power motor is put into operation, the magnetic

clutch is automatically operated to connect the shafts when the first-named motor is idle.

80. Glass pavement-light. FREDERICK L. KEPPLER. U. S. 1,385,688, July 26, 1921. As a new article of manuf., a tile unit comprising a glass body with a substantially flat upper surface, a depending rim about its edge, a plurality of projections from the lower surface of the tile, within the rim, shaped to form strengthening and light diffusing areas, and a series of abrasive plugs set in the upper surface of the tile above the projections, each plug lying well within the boundary of the projections over which it is placed.

81. Apparatus for grinding and polishing plate-glass. FRANK EDWIN SLOCOMBE. England. U. S. 1,384,278, July 12, 1921. In a sucker device, adapted to hold glass on to a grinding or polishing table the combination with a sucker movable relatively to the table and to which the glass is attached by atmospheric pressure, of pneumatic means operatively connected to the sucker for allowing the glass to be pressed against the table by atmospheric pressure, the relative areas of the glass and pneumatic means which are subjected to the said pressure being such that, of the total atmospheric pressure on the glass due to whatever degree of vacuum there may be in the sucker device, a portion determined by the dimensions of the latter operates to press the glass on to the table while the remainder presses the glass on to the sucker.

82. Apparatus for the manufacture of glassware. WILLIAM H. MCSWAIN. U. S. 1,384,967, July 19, 1921. An app. for the manuf. of pressed articles of glassware, comprising a platform, an endless carrier arranged for continuous travel over the platform, a plurality of molds borne by the carrier at regular intervals, a press disposed over the path of travel of the molds, the press being arranged to advance successively with the molds throughout a definite distance, means actuated during forward travel of the press for reciprocating the plunger of the latter with respect to an underlying mold for shaping the ware, and a glazing oven through which the molds travel following the ware-shaping operation.

83. Glass-tank furnace. JOSEPH E. HURLEY. U. S. 1,390,614, Sept. 13, 1921. A glass-tank furnace, comprising tanks forming the walls thereof, means for supplying water to the tanks, a fibrous facing on the inner walls of the tank, and a passage formed between the walls of the tank and the facing, the passage communicating with the tank.

84. Glassware-machine. EDMA H. CURTIS, JR. U. S. 1,386,240, Aug. 2, 1921. In a leer, the combination with interspaced fixed and movable supports for glassware in the leer, and a conveyer member having fixed supports corresponding to the fixed supports of the leer, of a driving member common to the movable supports and the conveyer, and adapted to move the movable supports to unload the conveyer member and to move the conveyer member into and out of the leer, the driving member timed to thrust forward the movable supports after the conveyer member is in place in the leer, then lift the supports, then withdraw the supports, and then move the conveyer member out of the leer.

85. Apparatus for drawing glass cylinders. ARTHUR E. SPINASSE. U. S. 1,386,441, Aug. 2, 1921. In an app. for drawing glass cylinders, a furnace, a forehearth extending from the furnace, a wall between the two, a recess in the wall and cooling means in the recess, a cover for the forehearth having an opening therein, a ring in the opening, a support for the ring, the support extending under the ring, means for raising and lowering the support and ring, and a glass segregating element adapted to float in the glass in the forehearth and to rise into contact with the ring support without adhesion.

86. Glass construction unit. FREDERICK L. KEPPLER. U. S. 1,386,409, Aug. 2, 1921. A new article of manuf. A glass tile comprising a relatively thin portion, downwardly depending edges having corrugated outer surfaces, a band of cement material let into the corrugations, the outer surface of the band being channeled. C. M. SAEGER, JR.

See also No. 24.

Cement, Lime and Plaster

87. Transformation of light magnesia into the dense form. N. PARRAVANO AND C. MAZZETTI. *Atti accad. Lincei*, **30**, i, 63–66(1921).—The results of the authors' expts. show that the velocity of hydration of MgO diminishes as the temp. and duration of its previous calcination are increased, no discontinuity being observable. The statement that MgO undergoes transformation at about 1600° (Le Chatelier, *Le Chauffage*, 399) or 1100° (Campbell, *C. A.*, **12**, 268) is inaccurate, this change having already begun at the lowest temp. employed by the authors, namely 800°, at which, however, it proceeds very slowly. This result is confirmed by Ditte's measurements of the d. of the oxide after being heated at definite temps. for a certain time (*J. Chem. Soc.*, **24**, 869(1871)). Natural magnesites contain impurities which exert a marked influence on the velocity of hydration of the oxide resulting from their calcination, the transformation into the dense modification being facilitated. This change is at first slow and continually increases in rapidity as the temp. is raised, and no definite transformation temp. probably exists.

J. C. S. (*C. A.*)

88. Special ferriferous agglomerate and its applications in presence of pozzuolanous substances. FABIO FERRARI. *Giorn. chim. ind. applicata*, **3**, 53–56(1921).—The ferriferous agglomerate had the following compn.: SiO_2 = 24.04%, insol. siliceous residue = 0.28, Al_2O_3 = 3.32, Fe_2O_3 = 5.24, CaO = 65.10, MgO = 0.47, SO_3 = 0.61, alkali (not detd.) = 0.94. F. drew the following conclusions from this study: (1) Cements of this type, in which the sesquioxides stand in equiv. relations, are free from binary combinations of these sesquioxides. They are, therefore, stable towards the action of sulphates and chlorides. Since the greatest fusibility of the material forming the second consolidation of the clinkers corresponds to the existence of the above mentioned equiv. proportions, the above type of cements may be regarded as products showing the easiest scorification and containing the greatest amounts of hydraulics (Ca silicates). They may, therefore, be substituted in all

applications, not only of ferroportlands, but also of ordinary Portlands. (2) Pozzuolanous substances added to the above type of cements moderate their high basicity and fit them for mortars of the highest permeability. These mixts. also possess a mechanical resistance greater than mortars of ordinary Portlands in general use. ROBERT S. POSMONTIER (*C. A.*)

89. Electrified cement industry. LLOYD W. CHAPMAN. *J. Elec. Western Ind.*, **47**, 7–9(1921).—The method of manuf. Portland cement at the Santa Cruz Portland Cement Co. is briefly described with 5 illustrations. About 60% of the K_2O that enters the plant is recovered. The product contains about 33% K_2O, is completely sol. in water and is very suitable for fertilizers, being free from any injurious impurities. The K is recovered from the dust by a Cottrell precipitator. C. G. F. (*C. A.*)

90. Law governing the hardening of cement. J. BIED AND E. GARNIER. *Rev. ing. index tech.*, **28**, 269–72(1921).—The tensile strength of cement after 84 days can be calcd. from the strengths at 7 and 28 days from the formula $R_{84}=K(2R_{28}-R_7)$ where K is a const. which is very near 1 for all except quick-setting cements. Hence the hardening equation is hyperbolic and is $(t-3.6)(h-2.7)=152$ for cements and $(t-8.5)(h-8.7)=429$ for limes, where t is the time (the meaning of h is not given). Calcd. and detd. values are given for 2 samples and show very close agreement. A. P.-C. (*C. A.*)

91. The physical properties of magnesia cement and magnesia cement compounds. R. J. ROARK. *Bull. Univ. Wis. Eng. Series*, **8**, No. 5, 257–331 (1917); *Expt. Sta. Record* **43**, 282.—This bulletin presents the results of an exptl. study of the physical properties of magnesia cement and magnesia cement compds. and of the factors affecting these properties. An important object of the investigation was the detn. of physical tests which could be relied upon to indicate the suitability or unsuitability of particular cements or compds. for use as flooring material. A description of magnesia cement, its manuf. and uses, is given, together with a summary of the results of chem. investigations. H. G. (*C. A.*)

92. Lime kilns and lime burning. RICHARD K. MEADE. *Sugar*, **23**, 264–66 (1921).—The various types of lime kilns are described. A water-jacketed cooling cone gives longer service. Reinforced concrete was used to replace the steel jacket for the kiln with excellent results. Relative values of fuels are summarized: one ton bituminous coal hand-fired 3.5–4 tons lime; one ton coal fired as producer gas burns 3.5–5 tons lime; 1 bbl. oil fires 1–1.75 tons lime; 1 cord wood fires 2.25–2.75 tons lime. C. H CHRISTMAN (*C. A.*)

93. The equilibrium between Portland cement and limewater. RICHARD LORENZ & GUSTAV HAEGERMANN. *Z. anorg. allgem. Chem.*, **118**, 193(1921).—The material for expt. was prepd. by mixing with 12% H_2O, and compressing and ageing 28 days over H_2O and 7 days in a desiccator. It was then ground and screened through 180 and 220 mesh sieves and again stored over H_2O for two months. Samples of 0.5 to 4 grm. were stirred rapidly into 500 cc. H_2O in a Jena flask kept at constant temp. and stirred continuously. CaO was detd. in the filtrate. The rate of soln. of CaO increased regularly with

fineness and with temp. but irregularly with time. The first rapid soln. was followed by a period in which the CaO in soln. was constant: then the amt. of CaO in soln. increased asymptotically to a constant value. The same shape of curve was obtained repeatedly by treating with fresh portions of H_2O as long as any of the original clinker remained. The final insol. portion after all CaO had been leached out was gelatinous $SiO_2 + Al_2O_3$. The expt. data are interpretive as follows; First CaO is dissolved leaving $SiO_2 + Al_2O_3$. When the $Ca(OH)_2$ in soln. reaches a certain concn. it is adsorbed by the colloidal $SiO_2 + Al_2O_3$ during which period the $Ca(OH)_2$ in soln. remains const. When the gel is "saturated" the concn. of $Ca(OH)_2$ again increases. By repeating the treatment with fresh portions of H_2O until no clinker remained the distribution coeff., $\frac{\text{CaO adsorbed}}{\text{CaO in solution}}$ was found to approach a value of about 7. The author considers that these findings have an important bearing on the use of cement in contact with ground waters, sea waters, etc.

E. W. T.

PATENTS

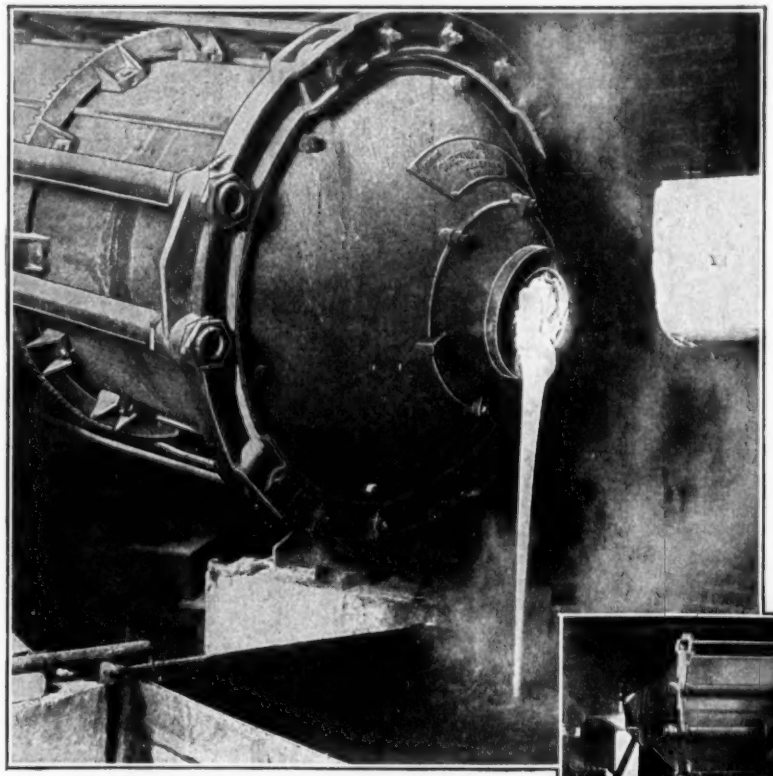
94. Magnesia plaster. Shôzaburô Mimura and Rokusaburô Yamamoto. Japan 36,733, July 8, 1920. Lower coating: A mixt. of 5% saw dust, 10% asbestos and 40% MgO is made to a paste with 44% $MgCl_2$ in 2–3% Pb acetate soln. Upper coating: A mixt. of 40% MgO, 5% powdered peanut husks, 10% asbestos and 5% pigment is made to a paste by the same $MgCl_2$ soln. in Pb acetate soln. The plaster is antiseptic and odorless. (*C. A.*)

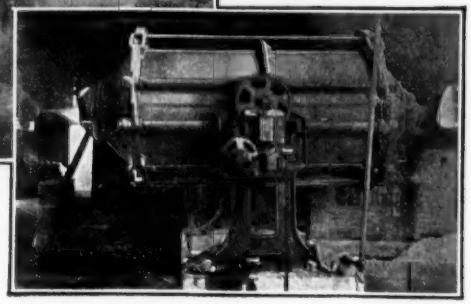
95. Plastic composition for bricks. John Smith. U. S. 1,385,757, July 26, 1921. A plastic compn. comprising cement, coal ashes and brick dust of substantially equal proportions. C. M. Saeger, Jr.

BOOK REVIEWS

A discussion of the making of reflecting surfaces. Held on Nov. 26, 1920 at the Imperial College of Science and Technology, South Kensington, S. W. 7, England. Price 5s. 6d. sent to The Optical Society at the above address. This booklet is a collection of the following papers ending with a general discussion. 1. Survey of the Bibliography of Metallic Deposition on Glass. By R. Kanthack. 2. A Bibliography of the more important Papers on the Construction and Nature of Reflecting Surfaces. By R. Kanthack. 3. Notes on the Formaldehyde Process of Silvering. By H. N. Irving. 4. Some Workshop Notes on Silvering. By James Weir French, D.Sc. (Messrs. Barr & Stroud, Ltd., Glasgow). 5. The Silvering of Glass Reflectors by Chemical Deposition. By F. Ellerman and H. D. Babcock (Mount Wilson Observatory). 6. The Silvering of a Large Reflector. By C. R. Davidson (Royal Observatory). 7. Note on the Silvering of Quartz and Glass Fibres. By R. S. Whipple, M. I. E. E. (The Cambridge and Paul Instrument Co., Ltd.). 8. Some Notes on Mirrors Used for Reflecting Heat Radiation. By Prof. Chas. Féry (École Municipale de Physique et de Chimie, Paris). 9.

Deposition of Metals by Cathodic Spluttering in Vacuo By F. Ellerman and H. D. Babcock (Mount Wilson Observatory). 10. Note on the Production of Mirrors by Cathodic Bombardment. By F. Simeon, B.Sc., F. Inst. P. (Messrs. Adam Hilger, Ltd.). 11. Platinum Reflecting Surfaces Prepared by the "Burning-in" Process. By Julius Rheinberg, F. R. M. S., F. R. P. S. 12. A Note on Mirrors for use in Optical Instruments under Industrial Conditions By W. G. Collins (The Cambridge and Paul Instrument Co. Ltd.). 13. A Photometric Method of Measuring the Reflecting Power of Mirrors. By John W. T. Walsh, M.A., M.Sc. (The National Physical Laboratory). 14. General Discussion.





These illustrations made from photographs taken in the plant of Ingram-Richardson Mfg. Co., Beaver Falls, Pa.

12-21

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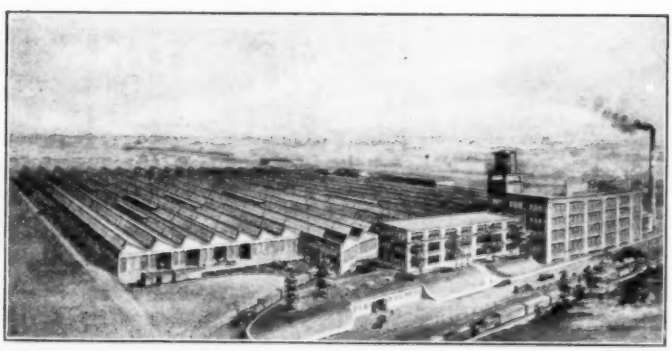

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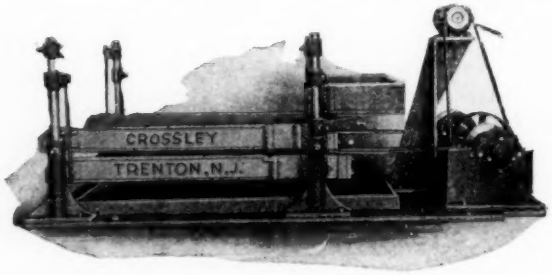

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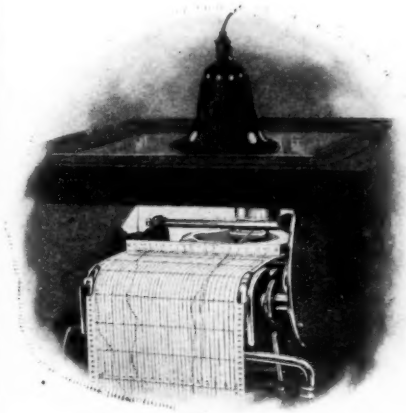

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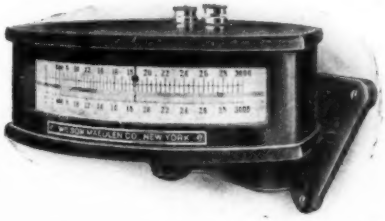

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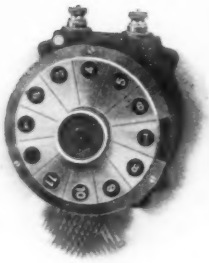

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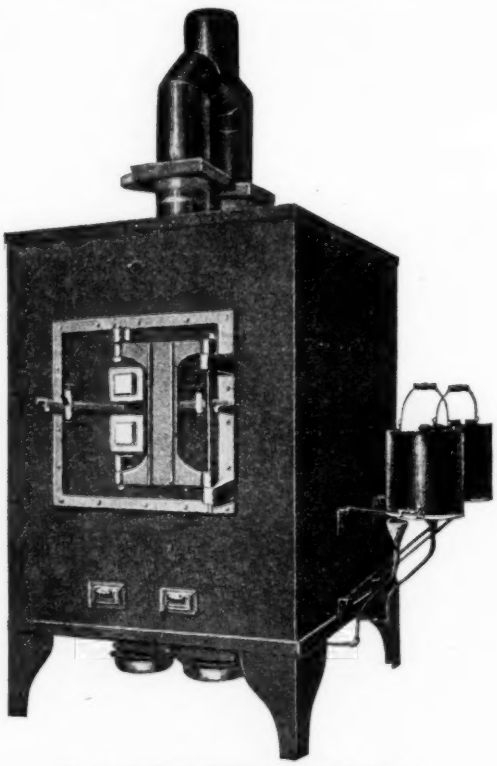

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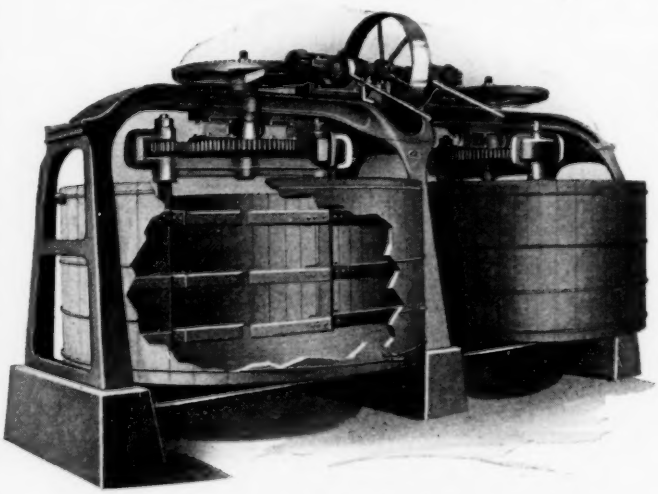

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